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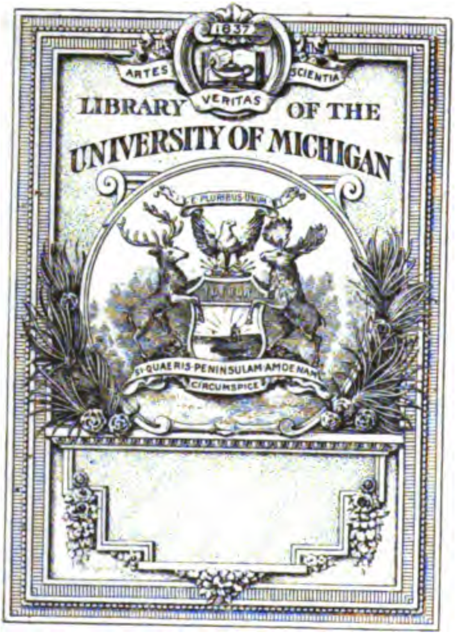

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# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 41.

APRIL, 1894.

## Analyses of Commercial Fertilizers.

I. SUMMARY. (Page 3.)
II. SCHEDULE OF TRADE VALUES. (Pages 4-5.)
III. ANALYSES OF LICENSED FERTILIZERS. (Pages 6-12.)
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V. ANALYSES OF WOOD ASHES, ETC. (Page 16.)

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# BULLETIN NO. 41. ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills and B. O. White.

## I. SUMMARY.

1. The trade values of fertilizing ingredients in mixed goods this year are 18½ cents per pound for nitrogen; 6, 5½ and 2 cents per pound for soluble, reverted, and insoluble phosphoric acids; 5¼ and 4½ cents per pound for sulphate and muriate of potash. (Page 4.)

2. *These trade values do not represent the proper selling prices of mixed goods at the point of consumption*, but are the retail cash prices, of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance (Page 5.)

3. The Station has analysed samples of fifty-three distinct brands of fertilizers, all taken this spring from dealers' stocks and all this year's goods. This is seventeen more than have been analysed in any previous year. Most of these seventeen are believed to be new in the State this year. So far as is known by the Station all but three brands sold in the State have been sampled and analysed. (Pages 6–11.)

4. Of the 53 brands analysed, 18, or one-third, are above guarantee in nitrogen, available phosphoric acid and potash; 28, or one-half, are deficient in a single ingredient; 6, or one-ninth, are deficient in two ingredients; 1 is below guarantee throughout. Of the 35 brands found deficient, 27 show by their analyses imperfect mixing at the factory. They contain a sufficient excess of other ingredients to afford an equivalent money value. It is safe to say that five-sixths of the brands sold in the State this year contain the commercial equivalent of their guarantees. The percentage of failure to meet guarantee is greater than has hitherto been found in this State. (Pages 6-11.)

5. The comparison of the average composition of the fertilizers sold in the State this year, with those of the past ten years shows that the 1894 goods are of poorer quality than any sold during this time. The average selling price is lower than ever before, being 85 cents less than last year, but the average valuation is $1.62 less than in 1893, based on the same (1894) trade values. (Pages 12–15.)

6. Since 1885 over ninety different brands of fertilizers have been sold in Vermont. Selling prices have dropped 17 per cent, and valuations 20 per cent. The per cent of cost over valuation was least in 1889, and is most now. Owing to the lower prices of nitrogen and phosphoric acid the buyer does not pay as much now for plant food as ten years ago, yet he pays more than at any time during the past six years. (Pages 13–15.)

7. Nineteen samples of ashes varied from 0.43 to 7.66, percent soluble potash, from 1.02 to 2.19 percent phosphoric acid and from 2.25 to 67.40 percent insoluble matter and sand. The prices for these goods were not in accordance with their composition. It is always best to buy ashes on the analysis of the Experiment Station. (Page 16.)

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## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this State, in 1894, is the one agreed upon by the experiment stations of Massachusetts, Rhode Island, Connecticut and New Jersey, after a careful study of prices ruling in the large markets of New England and the Middle States :

### TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1893 and 1894.

| | 1893. cts. per lb. | 1894. cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 17 | 19 |
| " in nitrates | 15½ | 14½ |
| Organic nitrogen in dried and fine ground fish, | | |
| " " blood and meat and in high grade mixed fertilizers | 17½ | 18½ |
| " " in cotton seed meal, linseed meal and castor pomace | 16½ | 15 |
| " " in fine ground bone and tankage | 15 | 16½ |
| " " in fine medium " " | 12 | 15 |
| " " in medium " " | 9 | 12 |
| " " in coarse " " | 7 | 7 |
| " " in horn shavings, hair and fish scrap | 7 | 7 |
| Phosphoric acid soluble in water | 6½ | 6 |
| " " " in ammonium citrate* | 6 | 5½ |
| " " " in fine ground fish, cotton seed meal, linseed meal, castor pomace and wood ashes | 5 | 5 |
| " " in dry fine ground fish and in fine bone and tankage | 6 | 5½ |
| " " in fine medium bone and tankage | 5 | 4½ |
| " " in medium " " | 4 | 3 |
| " " in coarse " " | 3 | 2 |
| " " insoluble (in ammonium citrate) in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate | 5½ | 5¼ |
| Potash as muriate | 4½ | 4¼ |

The above trade values are the average figures at which in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st, plus about 20 per cent, in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable retail price at the large markets of standard raw materials such as, Sulphate of Ammonia, Nitrate of Soda, Muriate of Potash, Sulphate of Potash, Dried Blood, Plain Superphosphate, Azotin, Dry Ground Fish, Ammonite, Castor Pomace, Bone and Tankage, Ground South Carolina or Florida Rock.

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* Dissolved from 2 grams of the unground phosphate previously extracted with pure water by 100 c. c. neutral solution of Ammonium Citrate sp. gr. 1.09 in 30 minutes at 65 degrees C., with agitation once in five minutes. Commonly called "reverted," or "backgone" Phosphoric Acid.

## APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS.

The trade values are applied to the valuation of superphosphates and all mixed goods as follows:

The nitrogen is valued at 18½ cents per pound, it being assumed that it is from such materials as ammonia salts, nitrates, dried blood, ground fish or nitrogenous substances of equally good quality.

The insoluble phosphoric acid of mixed fertilizers is reckoned at 2 cents per pound.

The potash is valued at 4¼ cents per pound, the price of that ingredient in kainite and muriate if there is sufficient chlorin in the fertilizer to unite with all the potash; if not such as is not thus united is valued at 5¼ cents per pound, the price of that ingredient in high grade sulphate.

The valuation of a fertilizer is obtained by multiplying the percentage of the several ingredients by 20 (which gives the pounds per ton), and these products by the prices per pound.

As these estimated values are not intended to represent the proper selling price of mixed goods at the point of consumption, and in order to prevent any possible misapprehension as to their real meaning, the following explanations are offered:

1. These trade values represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, in their various forms, can now be purchased, for cash at retail in our large markets. The are based mostly upon the ton prices at which certain classes of goods are offered to actual consumers.

2. These trade values do not include the charges for transportation from the market to the consumer, for storage, mixing, commissions to agents and dealers, selling on long credit, bad debts, etc., etc.

3. They are the prices of nitrogen, phosphoric acid and potash, *ready for use by the farmer*, when these ingredients are purchased under the above named conditions, singly and not mixed. In ordinary superphosphates we find these three ingredients mixed, but this is not a necessary condition of their use.

An illustration may serve to make clear the above statements: A farmer wishes a ton of fertilizer similar to the well-known brands sold in this State. If he purchases for cash in New York or Boston, one hundred (100) pounds of muriate of potash, fifty (50) pounds of sulphate of ammonia, fifty (50) pounds of nitrate of soda and fifteen hundred and fifty (1550) pounds of dissolved South Carolina rock, known in the trade as "acid phosphate," and mixes these ingredients together, he will have a complete fertilizer, not essentially different from many standard brands of ammoniated superphosphates. The cost of the ton after mixing (if the farmer prefers to mix the ingredients) will be made up as follows:

(*a*) Cost of the materials in the markets.
(*b*) Cost of transportation.
(*c*) Cost of mixing.

The first element entering into the total cost, is the only one included in the "valuation." If there is added to this one element, not only the charges for transportation and mixing, but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary superphosphates, when delivered at or near the place of consumption.

4. The station valuations stand in no direct or necessary relation to the comparative profits which may be derived from the use of various fertilizers by individual farmers. These values have an almost purely commercial significance, and are not designed to point out to a farmer whether he shall use potash, which is comparatively a cheap ingredient, or nitrogen, which is comparatively costly.

For further information concerning fertilizer analyses and for an explanation of the meaning of the terms employed, the reader is referred to the previous reports and bulletins of the Station.

## III. LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1158 | Farm and Garden Phosphate, | Bowker Fertilizer Co., Boston, Mass. | Luther Putnam, Cambridge. | 1158 |
| 1146 | Hill and Drill Phosphate, | " " " " " | N. L. Parker, East Burke. | 1146 |
| 1084 | Potato Phosphate, | " " " " " | E. W. Gilman, Marshfield. | 1084 |
| 1152 | Potato Phosphate, | " " " " " | G. L. Pease, Williston. | 1152 |
| 1104 | Potato and Vegetable Manure, | " " " " " | W. R. Spaulding. E. Wallingford. | 1104 |
| 1082 | Stockbridge Corn Manure, | " " " " " | L. C. Fisher, Cabot. | 1082 |
| 1147 | Stockbridge Potato Manure, | " " " " " | N. L. Parker, East Burke. | 1147 |
| 1100 | Stockbridge Manure for Top Dress'g | " " " " " | Rumsey & St. John, Castleton. | 1100 |
| 1102 | Sure Crop Phosphate, | " " " " " | Rumsey & St. John, Castleton. | 1102 |
| 1129 | B. D. Sea Fowl Guano, | Bradley Fertilizer Co., Boston, Mass. | J. H. Lamson, West Randolph. | 1129 |
| 1128 | Complete Manure for Potatoes and Vegetables, | " " " " " | J. H. Lamson, West Randolph. | 1128 |
| 1099 | Complete Manure for Top Dressing Grass and Grain, | " " " " " | G. F. Hendee, Pittsford. | 1099 |
| 1095 | Corn Phosphate, | " " " " " | Thomas & Weeks, Middlebury. | 1095 |
| 1085 | Eclipse Fertilizer, | " " " " " | G. D. Kidder, Plainfield. | 1085 |
| 1081 | Potato Fertilizer, | " " " " " | J. A. Farrington, Cabot. | 1081 |
| 1112 | Potato Manure, | " " " " " | O. L. Minor, Brattleboro. | 1112 |
| 1073 | X L Superphosphate of Lime, | " " " " " | Ira Thorp, Underhill. | 1073 |
| 1145 | Bay State Fertilizer, | Clarks Cove Guano Co., Boston, Mass. | D. C. Gage, St. Johnsbury. | 1145 |
| 1078 | Corn and Grain Fertilizer. | Cleveland Dryer Co., Cleveland, O. | A. S. C. Hill, Johnson. | 1078 |

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | **Brand.** | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1158 | Bowker's F'rm & Gard'n Phosphat | 1.12 | - - - | 0.75 | 1.87 | 1.5 | $6.92 | 3.07 | 4.77 | 2.87 | 10.71 | 10 | 7.84 | 8 | $10.08 | 2.47 | 2 | $2.22 | 3.75 | 1158 |
| 1146 | " Hill & Drill Phosphate | 0.65 | 0.40 | 1.38 | 2.48 | 2.5 | 8.99 | 4.88 | 4.72 | 2.35 | 11.95 | 12 | 9.60 | 9 | 11.97 | 2.14 | 2 | 1.93 | 5.85 | 1146 |
| 1084 | " Potato Phosphate...... | 0.73 | 0.11 | 1.04 | 1.88 | 1.5 | 6.96 | 4.23 | 3.57 | 2.93 | 10.72 | 11 | 7.79 | 9 | 10.17 | 2.06 | 2 | 1.85 | 3.00 | 1084 |
| *1152 | " " " ...... | 0.97 | 0.10 | 0.83 | 1.90 | 1.5 | 7.03 | 3.46 | 4.63 | 2.74 | 10.83 | 11 | 8.09 | 9 | 10.84 | 2.05 | 2 | 1.84 | 3.75 | 1152 |
| 1104 | " Pot'to & V'g't'ble M'nure | 1.17 | - - - | 1.07 | 2.24 | 2.5 | 8.29 | 4.51 | 4.02 | 3.54 | 12.07 | 10 | 8.58 | 8 | 11.25 | 4.68 | 4 | 4.21 | 4.65 | 1104 |
| 1082 | " St'ckbridge Corn M'nure | 1.85 | 0.11 | 1.21 | 3.17 | 3.25 | 11.73 | 5.36 | 3.87 | 3.21 | 12.44 | 10 | 9.28 | 8 | 11.97 | 4.13 | 4 | 4.05 | 1.70 | 1082 |
| 1147 | " " Potato " | 1.58 | 0.10 | 1.45 | 3.13 | 3.25 | 11.58 | 6.22 | 1.57 | 2.11 | 9.90 | 8 | 7.79 | 6 | 10.04 | 6.21 | 7 | 6.30 | 1.35 | 1147 |
| 1100 | " " Top Dressing | 2.35 | 0.10 | 2.51 | 4.96 | 5. | 18.85 | 1.99 | 2.68 | 4.43 | 9.10 | 6 | 4.67 | 4 | 7.11 | 6.21 | 6 | 5.59 | 7.01 | 1100 |
| 1102 | " Sure Crop Fertilizer.... | 0.40 | - - - | 0.43 | 0.83 | 0.75 | 3.07 | 3.00 | 5.23 | 4.04 | 12.27 | 10 | 8.23 | 8 | 10.97 | 1.08 | 1 | 0.97 | 2.60 | 1102 |
| 1129 | Bradley's B. D. Sea Fowl Guano | 0.56 | 0.16 | 2.05 | 2.81 | 2.5 | 10.40 | 5.68 | 3.93 | 2.41 | 12.02 | 11 | 9.61 | 9 | 12.10 | 1.91 | 2 | 1.72 | 2.47 | 1129 |
| 1128 | " Complete, Potatoes and Vegetables.......... | 1.20 | - - - | 2.62 | 3.82 | 3.75 | 14.13 | 4.25 | 4.19 | 2.77 | 11.21 | 9 | 8.44 | 8 | 10.82 | 5.71 | 6 | 5.14 | 6.05 | 1128 |
| 1099 | " C'mpl'te Top Dress'g &c | 2.66 | - - - | 2.52 | 5.18 | 4.95 | 19.17 | 1.34 | 3.74 | 1.67 | 6.75 | 6 | 5.08 | 5 | 6.39 | 2.99 | 2.5 | 3.11 | 0.60 | 1099 |
| 1095 | " Corn Phosphate....... | 0.44 | 0.18 | 1.70 | 2.32 | 2.05 | 8.58 | 7.09 | 2.67 | 1.39 | 11.15 | 10 | 9.76 | 9 | 12.01 | 1.78 | 1.5 | 1.60 | 2.37 | 1095 |
| 1085 | " Eclipse Fertilizer...... | 0.47 | 0.11 | 1.23 | 1.81 | 1. | 6.70 | 5.41 | 4.54 | 2.07 | 12.02 | 12 | 9.95 | 10 | 12.81 | 1.62 | 1.5 | 1.46 | 2.48 | 1085 |
| 1081 | " Potato Fertilizer........ | 0.41 | 0.18 | 1.61 | 2.20 | 2.05 | 8.14 | 6.62 | 2.84 | 0.94 | 10.40 | 11 | 9.46 | 9 | 11.44 | 2.94 | 3.25 | 2.65 | 3.05 | 1081 |
| 1112 | " " Manure ....... | 1.15 | - - - | 1.00 | 2.15 | 2.5 | 7.96 | 5.05 | 1.44 | 1.02 | 7.51 | 8 | 6.49 | 6 | 8.05 | 5.12 | 5 | 4.61 | 5.98 | 1112 |
| 1073 | " XL Superphosphate.. | 0.26 | 0.17 | 2.18 | 2.63 | 2.5 | 9.73 | 6.34 | 2.67 | 1.52 | 10.53 | 11 | 9.01 | 9 | 11.15 | 2.26 | 2 | 2.03 | 2.28 | 1078 |
| 1145 | Clark's Cove Bay State Fertilizer | 0.19 | 0.16 | 2.32 | 2.67 | 2.47 | 9.88 | 6.58 | 2.06 | 1.63 | 10.27 | 10 | 8.64 | 9 | 10.81 | 2.08 | 2 | 1.88 | 2.10 | 1145 |
| 1078 | Cleveland Corn & Grain " | 0.39 | 0.14 | 1.87 | 2.40 | 2.05 | 8.88 | 6.12 | 2.62 | 1.79 | 10.58 | 10.5 | 8.74 | 9.5 | 10.94 | 1.78 | 1.5 | 1.56 | 1.88 | 1078 |

*Station No. 1152 was analyzed at the request of the manufacturers, who claimed that Station No. 1084 did not truly represent their goods.

## LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1131 | Fertilizer for all Crops, | Cleveland Dryer Co., Cleveland, O. | F. H. Packard, Braintree. | 1131 |
| 1130 | Potato Phosphate, | “ “ “ “ “ | F. H. Packard, Braintree. | 1130 |
| 1087 | Alkaline Bone, | E. Frank Coe Co., New York, N. Y. | Barrows & Peck, Montpelier. | 1087 |
| 1103 | Columbian Bone Superphos., | “ “ “ “ “ “ | E. M. Bixby, Poultney. | 1103 |
| 1092 | Grass and Grain Fertilizer, | “ “ “ “ “ “ | Farnsworth & Co., Middlebury. | 1092 |
| 1094 | High Grade Ammoniated Bone Superphosphate, | “ “ “ “ “ “ | Farnsworth & Co., Middlebury. | 1094 |
| 1088 | XXV Ammo. Bone Superphos., | “ “ “ “ “ “ | Barrows & Peck, Montpelier. | 1088 |
| 1071 | Ammoniated Corn Phosphate, | Crocker Fert. & Chem. Co., Buffalo, N.Y. | E. B. Williams, Jericho. | 1071 |
| 1124 | Ammo. Wheat & Corn Phos., | “ “ “ “ “ “ | Edwin Morse, Bethel. | 1124 |
| 1072 | New Rival Ammo. Superphos., | “ “ “ “ “ “ | E. B. Williams, Jericho. | 1072 |
| 1117 | Potato, Hop and Tobacco Phos. | “ “ “ “ “ “ | W. V. Hardy, East Concord. | 1117 |
| 1075 | Ammoniated Corn Phosphate, | “ “ “ “ “ “ | G. J. Perkins, Hardwick. | 1080 |
| 1080 | Special Potato Manure, | “ “ “ “ “ “ | R. Brush, Cambridge. | 1075 |
| 1133 | Fertilizer, | Cumberland Bone Phos. Co., Portland, Me, | J. M. Temple, Northfield. | 1133 |
| 1110 | Potato Fertilizer, | “ “ “ “ “ “ | W. H. & E. S. Minor, Brattleboro. | 1110 |
| 1106 | Superphosphate, | “ “ “ “ “ “ | W. P. Dodge, Chester. | 1106 |
| 1123 | Potato Manure, | Davidge Fertilizer Co., New York, N. Y. | Sidney Walker, W. Windsor. | 1123 |
| 1122 | Special Favorite for Cereals, | “ “ “ “ “ “ | Sidney Walker, W. Windsor. | 1122 |

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | Brand. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1131 | Cleveland Fertilizer for all Crops | 0.47 | 0.11 | 1.53 | 2.11 | 1.1 | $7.81 | 6.00 | 3.30 | 2.38 | 11.68 | 9 | 9.30 | 8 | $11.78 | 1.68 | 2 | $1.51 | 2.85 | 1131 |
| 1130 | Cleveland Potato Phos. | 0.39 | 0.13 | 1.91 | 2.43 | 2.05 | 8.99 | 6.00 | 3.03 | 2.00 | 11.03 | 10 | 9.03 | 8 | 11.33 | 2.88 | 3 | 2.59 | 3.00 | 1130 |
| 1087 | Coe's Alkaline Bone | ---- | 0.12 | 1.32 | 1.45 | 1.28 | 5.37 | 6.71 | 2.04 | 3.17 | 11.92 | 11 | 8.75 | 9 | 11.56 | 2.28 | 1.6 | 2.34 | 0.33 | 1087 |
| 1103 | " Columbian Bone | ---- | 0.11 | 1.20 | 1.31 | 1 | 4.85 | 6.52 | 2.29 | 3.19 | 12.00 | 11 | 8.81 | 9 | 11.62 | 2.25 | 1.85 | 2.30 | 0.40 | 1103 |
| 1092 | " Grass & Grain Fert. | ---- | 0.10 | 0.92 | 1.02 | 0.85 | 3.77 | 6.77 | 2.94 | 3.74 | 13.45 | 10 | 9.71 | 9 | 12.85 | 1.65 | 1.35 | 1.70 | 0.15 | 1092 |
| 1094 | " High Grade Ammo. Bone | ---- | 0.56 | 1.73 | 2.29 | 2.05 | 8.47 | 6.47 | 2.26 | 3.17 | 11.90 | 11 | 8.73 | 9 | 11.52 | 2.12 | 1.85 | 2.06 | 1.05 | 1094 |
| 1088 | Coe's XXV. Ammo. Bone | ---- | 0.10 | 1.48 | 1.58 | 1 | 5.85 | 7.28 | 3.21 | 3.36 | 13.85 | 9 | 10.49 | 8 | 13.61 | 1.41 | 1 | 1.41 | 0.45 | 1088 |
| *1071 | Crocker's Ammo Corn Phosphate | ---- | ---- | 2.27 | 2.27 | 2 | 8.40 | 6.78 | 2.37 | 1.03 | 10.18 | 11 | 9.15 | 10 | 11.16 | 1.86 | 1.6 | 1.67 | 1.75 | 1071 |
| 1124 | Crocker's Ammo. Wheat and Corn | ---- | ---- | 1.90 | 1.90 | 2 | 7.08 | 6.58 | 3.13 | 1.84 | 11.55 | 11 | 9.71 | 10 | 12.08 | 2.09 | 1.6 | 1.88 | 2.30 | 1124 |
| 1072 | Crocker's New Rival Superphosphate | ---- | 0.11 | 1.44 | 1.55 | 1.2 | 5.74 | 6.20 | 2.97 | 1.46 | 10.63 | 10 | 9.17 | 10 | 11.29 | 1.94 | 1.6 | 1.75 | 1.80 | 1072 |
| 1117 | Crocker's Potato, Hop, &c. | ---- | ---- | 2 26 | 2.26 | 2 | 8.36 | 7.14 | 1.99 | 1.78 | 10.91 | 11 | 9.13 | 10 | 11.47 | 3.28 | 3.2 | 2.95 | 3.55 | 1117 |
| *1075 | " " " " | ---- | ---- | 1.98 | 1.98 | 2 | 7.33 | 6.59 | 2.32 | 1.97 | 10.88 | 11 | 8.91 | 10 | 11.25 | 3.28 | 3.2 | 2.95 | 3.25 | 1075 |
| 1080 | " Special Potato | ---- | 0.19 | 3.34 | 3.53 | 3.7 | 13.06 | 7.16 | 1.19 | 0.59 | 8.94 | 9 | 8.35 | 8 | 10.14 | 5.63 | 5.4 | 5.07 | 6.03 | 1080 |
| 1133 | Cumberland Fertilizer | ---- | ---- | 1.19 | 1.19 | 1.08 | 4-40 | 4.61 | 3.05 | 2.10 | 9.76 | 10 | 7.66 | 8 | 9.73 | 2.18 | 2 | 1.96 | 2.50 | 1133 |
| 1110 | " Potato Fert. | 0.40 | ---- | 1.87 | 2.27 | 2 | 8.40 | 5 02 | 2.55 | 1.75 | 9.32 | 11 | 7.57 | 9 | 9.53 | 4.28 | 3 | 3.85 | 5.15 | 1110 |
| 1106 | " Superphos. | 0.83 | ---- | 1.29 | 2.12 | 2 | 7.84 | 5.82 | 3.34 | 2.32 | 11.48 | 10 | 9.16 | 8 | 11.59 | 2,14 | 2 | 1.93 | 3.10 | 1106 |
| 1123 | Davidge's Potato Manure | ---- | ---- | 2.49 | 2.49 | 2.88 | 9.21 | 7.94 | 1.68 | 0.68 | 10.30 | 10 | 9.52 | 9 | 11.65 | 4.13 | 4 | 4.29 | 0.30 | 1123 |
| 1122 | " Special Favorite for Cereals | ---- | ---- | 1.23 | 1.23 | 1.28 | 4.55 | 4.15 | 5.21 | 3.15 | 12.51 | 11 | 9.36 | 10 | 11.97 | 2.51 | 1.5 | 2.59 | 0.33 | 1122 |

*Station Nos. 1071 and 1075 were analyzed at the request of the manufacturers, who claimed that Nos. 1125 and 1127 did not truly represent their goods.

## LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1091 | Success Fertilizer, | Lister's Ag'l Chem. Works, Newark, N. J. | F. H. Foss, Vergennes. | 1091 |
| 1090 | Soluble Pacific Guano. | Pacific Guano Co., Boston. Mass. | C. A. Booth's Son & Co., Vergennes. | 1090 |
| 1111 | Special Potato Manure, | " " " " " | O. L. Minor, Brattleboro. | 1111 |
| 1134 | Climax Phosphate, | Quinnipiac Co., Boston, Mass. | G. R. Andrews, Northfield. | 1134 |
| 1125 | Corn Manure, | " " " " | J. H. Hewitt, So. Royalton. | 1125 |
| 1108 | Market Garden Manure, | " " " " | Mellin & Proctor, Brattleboro. | 1108 |
| 1107 | Phosphate, | " " " " | W. P. Dodge, Chester. | 1107 |
| 1121 | Potato Manure, | " " " " | C. F. Reaury, West Concord. | 1121 |
| 1136 | Potato and Tobacco Fertilizer | " " " " | Seneca Place, Essex Junction. | 1136 |
| 1096 | Farmer's Friend Superphos., | Read Fertilizer Co., Syracuse, N. Y. | Daniel Austin, Sr., Pittsford. | 1096 |
| 1076 | Bone, Fish and Potash, | " " " " " | S. D. Whiting, Johnson. | 1076 |
| 1077 | Leader Guano, | " " " " " | S. D. Whiting, Johnson. | 1077 |
| 1097 | Standard, | " " " " " | Daniel Austin, Sr., Pittsford. | 1097 |
| 1150 | Standard Fertilizer, | Standard Fertilizer Co., Boston, Mass. | J. H. Bushnell, Williston. | 1150 |
| 1151 | Standard Guano, | " " " " " | J. H. Bushnell, Williston. | 1151 |
| 1070 | Americus Ammo. Bone Superphosphate, | Williams & Clark Co., New York, N. Y. | M. V. Willard, Jericho. | 1070 |
| 1119 | Americus Corn Phosphate, | " " " " " " | S. T. Dudley, West Concord. | 1119 |
| 1118 | Potato Phosphate, | " " " " " " | S. T. Dudley, West Concord. | 1118 |
| 1114 | Royal Bone Phosphate, | " " " " " " | O. L. Minor, Brattleboro. | 1114 |

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1091 | Lister's Success Fertilizer | ... | 0.25 | 1.28 | 1.53 | 1.23 | $5.66 | 7.43 | 1.46 | 2.61 | 11.50 | 10.5 | 8.89 | 9.5 | $11.57 | 2.11 | 2 | $1.90 | 1.78 | 1091 |
| 1090 | P. G. Co.'s Sol. Pacific Guano | 0.50 | ... | 1.81 | 2.31 | 2.25 | 8.55 | 5.80 | 2.83 | 2.13 | 10.76 | 10.5 | 8.63 | 8.5 | 10.92 | 2.49 | 2 | 2.24 | 3.28 | 1090 |
| 1111 | " Spec. PotatoManure | 0.93 | ... | 1.54 | 2.47 | 2.47 | 9.14 | 4.44 | 4.03 | 1.28 | 9.75 | 7 | 8.47 | 5 | 10.27 | 5.48 | 5 | 4.93 | 6.23 | 1111 |
| 1134 | Quinnipiac Climax Phosphate | ... | ... | 1.26 | 1.26 | 1.03 | 4.66 | 5.39 | 2.81 | 2.19 | 10.39 | 9 | 8.20 | 8 | 10 44 | 2.42 | 2 | 2.18 | 3.10 | 1134 |
| 1125 | " Corn Manure | ... | 0.10 | 2.33 | 2.43 | 2.05 | 8.99 | 6.27 | 3.83 | 2.11 | 12.21 | 10 | 10.10 | 9 | 12.58 | 1.65 | 1.5 | 1.48 | 2.58 | 1125 |
| *1108 | " Market GardenM're | 1.28 | ... | 2.00 | 3.28 | 3.30 | 12.14 | 4.68 | 4.04 | 2.28 | 11 00 | 9 | 8.72 | 8 | 10.97 | 6.08 | 7 | 5.47 | 6.38 | 1108 |
| 1107 | " Phosphate | ... | 0.12 | 2.36 | 2.48 | 2.47 | 9.18 | 7.01 | 2.60 | 0.85 | 10.46 | 10 | 9.61 | 9 | 11.61 | 1.82 | 2 | 1.64 | 2.45 | 1107 |
| 1121 | " Potato Manure | 1.02 | ... | 1.39 | 2.41 | 2.47 | 8.92 | 3.12 | 2.41 | 2.42 | 7.95 | 7 | 5.53 | 6 | 7.36 | 4.73 | 5 | 4.26 | 6.03 | 1121 |
| 1136 | " Potato and Tobacco | 0.69 | 0.14 | 1.39 | 2.22 | 2.05 | 8.21 | 6.39 | 3.16 | 1.15 | 10.70 | 9 | 9.55 | 8 | 11.60 | 3.01 | 3 | 2.71 | 3.08 | 1136 |
| 1076 | Read's Bone, Fish and Potash | 1.07 | 0.25 | 1.40 | 2.72 | 2.47 | 10.06 | 2.76 | 1.43 | 0.48 | 4.67 | 5 | 4.19 | 4 | 5.08 | 6.00 | 4 | 5.40 | 5.75 | 1076 |
| 1096 | " Farmer's Friend | 0.64 | 0.11 | 0.94 | 1.69 | 2.05 | 6.25 | 5.73 | 2.93 | 1.98 | 10.64 | 10 | 8.66 | 9 | 10.90 | 2.10 | 2 | 1.89 | 3.84 | 1096 |
| 1077 | " Leader Guano | ... | 0.11 | 1.07 | 1.18 | 0.85 | 4.37 | 4.18 | 2.92 | 1.35 | 8.45 | 8 | 7.10 | 7 | 8.77 | 2.21 | 2 | 1.99 | 5.95 | 1077 |
| 1097 | " Standard | ... | ... | 0.97 | 0.97 | 9.85 | 3.59 | 5.78 | 2.05 | 1.63 | 9.46 | 9 | 7.83 | 8 | 9.84 | 3.89 | 4 | 3.50 | 7.00 | 1097 |
| 1150 | Standard Fertilizer | ... | ... | 2.06 | 2.06 | 2 | 7.62 | 5.74 | 2.76 | 2.51 | 11.01 | 10 | 8.50 | 8 | 10.98 | 2.24 | 2 | 2.02 | 3.25 | 1150 |
| 1151 | " Guano | ... | 0.14 | 1.05 | 1.19 | 1 | 4.41 | 4.99 | 2.74 | 1.94 | 9.67 | 10 | 7.73 | 8 | 9.78 | 1.87 | 2 | 1.68 | 2.00 | 1151 |
| 1070 | W. & C. Americus Ammo. Bone | ... | 0.12 | 2.37 | 2.49 | 2.47 | 9.21 | 6.06 | 3.50 | 2.12 | 11.68 | 10 | 9.56 | 9 | 11.97 | 2.07 | 2 | 1.86 | 2.45 | 1070 |
| 1119 | " " Corn | 0.44 | 0.10 | 1.91 | 2.45 | 2.55 | 9.07 | 5.44 | 3.40 | 2.30 | 11.14 | 10.5 | 8.84 | 9 | 11.19 | 1.91 | 1.5 | 1.72 | 1.93 | 1119 |
| 1118 | " Potato Phosphate | 1.01 | ... | 1.51 | 2.52 | 2.47 | 9.32 | 3.04 | 2.75 | 2.47 | 8.26 | 7 | 5.79 | 6 | 7.66 | 4.63 | 5 | 4.17 | 5.93 | 1118 |
| 1114 | " Royal Bone Phosphate | ... | 0.10 | 1.08 | 1.18 | 1.08 | 4.37 | 4.31 | 0.91 | 2.10 | 7.32 | 8 | 5.22 | 7 | 7.01 | 2.29 | 2 | 2.06 | 2.60 | 1114 |

* The manufacturers claim that this sample does not properly represent their goods. The Station vouches for the sample and its analysis. No other sample of this brand was found.

## COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1893 AND IN 1894.

Of the fifty-eight brands of commercial fertilizers sold in the State during 1893 and 1894, thirty-one standard brands have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands were selected which have been sold in the State during both of the years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1893 AND 1894.

| NAME OF INGREDIENTS. | 1893. | | 1894. | |
|---|---|---|---|---|
| | Pounds in a Hundred. | Valuation at 1894 Prices. | Pounds in a Hundred. | Valuation at 1894 Prices. |
| Nitrogen | 2.42 | $8.95 | 2.18 | $8.07 |
| Soluble Phosphoric Acid | 6.43 | 7.72 | 5.69 | 6.83 |
| Reverted Phosphoric Acid | 2.84 | 3.12 | 2.94 | 3.23 |
| Insoluble Phosphoric Acid | 2.29 | 0.92 | 2.01 | 0.80 |
| Available Phosphoric Acid | 9.27 | | 8.63 | |
| Total Phosphoric Acid | 11.56 | | 10.64 | |
| Potash | 2.72 | 2.45 | 2.90 | 2.61 |
| Total valuation per ton | | $23.16 | | $21.54 |

A comparison of the average compositions for the two years shows a very decided decrease in the quality of the goods sold this spring. The nitrogen has been lessened one-tenth, and the phosphoric acid one-twelfth. The potash has been increased one-fifteenth, but it should be remembered that it is commercially the least valuable of the fertilizing ingredients. The decrease in valuation is $1.62 while the average selling price has fallen less than a dollar. Organic nitrogen has increased in price, which in a measure explains the drop in nitrogen. Phosphoric acid however has become cheaper, yet less is placed in the average goods. The average composition is much lower than that of any previous year since the Station began sampling and analyzing licensed fertilizers under the State law.

The same decrease in quality this year will be found on reference to the tables on page 14, showing average analyses of what might be called the standard brands of the State and of all brands analyzed. The manufacturers as a whole are crowding closer to their lower guarantees than hitherto, and competition has affected quality more than price.

## IV. TEN YEARS OF FERTILIZER INSPECTION IN VERMONT.*

The State Legislature of 1882 passed an act commonly known as the "Vermont Fertilizer Law," which was replaced during the session of 1888 by a law similar in substance, but differing in detail. This law is now essentially the same as is found upon the statute books of most of the States.

For the past ten years the analyses of commercial fertilizers in accordance with the provisions of this law have been made at this station, and the data is at hand for a comparison of results of inspection and a review of the trade in the State.

During these ten years, twenty-two firms have offered the Vermont farmer over ninety brands of fertilizers, and there have been three-hundred and forty samples analyzed in the course of the regular inspection work, calling for nearly five thousand separate laboratory determinations.

During this time the average selling prices have fallen from $37.90 to $31.47 per ton, there being some decrease each year. This has been due mainly to competition and to the fall in the market prices of materials containing nitrogen and phosphoric acid. Nitrogen, in the better kinds of crude stock, cost 18 cents per pound in 1885, but may be bought now as nitrate for 14½ cents per pound. Soluble phosphoric acid has fallen in price in the same time from 9 cents to 6 cents, and reverted from 8 cents to 5½ cents per pound, while insoluble phosphoric acid has remained unchanged. Potash has advanced from 4¼ to 4½ cents per pound.

Two means may be used in calculating the average composition of the goods sold in the State. The analyses of those brands sold each and every year may be used, excluding others, or the analyses of all brands may be averaged. Neither will give the absolute average, for they give the same power in the result to a brand that is sold in small quantities as to one sold in large quantities. It is impossible to state the absolute average in the absence of data, showing the consumption of each brand.

There are usually from forty to sixty brands of goods sold each year in the State. They change from year to year, old brands dropping out and new ones appearing, the change being sometimes one of name only. Of the ninety brands analyzed since 1885, but seven have been found every year. They may be considered the standard brands of the State, and it is probably safe to say that more than half the gross amount of sales in the State have been from these goods. They are (stated in alphabetical order) Bowker's Hill and Drill Phosphate, Bowker's Stockbridge Potato Manure, Bradley's XL Superphosphate of Lime, Crocker's Buffalo Potato, Hop and Tobacco Phosphate, Cumberland Superphosphate, Qunnipiac Phosphate, and Quinnipiac Potato Manure.

The averages of analyses, selling prices, valuations, percentages of increase of cost over valuation†, and valuations of all at 1885 and at 1894 trade values of these seven brands are shown in the following table. Similar data averaging all brands analyzed each year, whether a standard brand or a new-comer, are shown in the table succeeding.

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*Condensed from Sixth Annual Report (1892), and revised to include data for 1894.

†The percentage of increase of cost over valuation. Example—1885 Standard Brands cost $39.40, valuation $28.97; $39.40—$28.97=$10.43, $10.43÷$28.97=36 per cent, i.e. $10.43 is the increase of the cost over the valuation, and 36 is the percentage of the same.

### AVERAGE ANALYSES OF STANDARD BRANDS.

| | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | 2.82 | 2.86 | 3.37 | 3.19 | 2.97 | 2.78 | 2.78 | 2.79 | 2.85 | 2.47 |
| Soluble Phos. Acid | 6.50 | 6.63 | 6.36 | 6.36 | 6.51 | 5.35 | 6.03 | 5.79 | 6.33 | 5.75 |
| Reverted " " | 1.95 | 2.12 | 2.46 | 3.56 | 3.63 | 3.98 | 3.57 | 2.85 | 2.91 | 2.77 |
| Insoluble " " | 1.64 | 1.69 | 2.02 | 2.05 | 1.92 | 2.54 | 1.96 | 2.25 | 2.19 | 1.92 |
| Available " " | 8.45 | 8.75 | 8.82 | 9.92 | 10.14 | 9.33 | 9.60 | 8.64 | 9.24 | 8.52 |
| Total " " | 10.09 | 10.44 | 10.84 | 11.97 | 12.06 | 11.87 | 11.56 | 10.89 | 11.43 | 10.44 |
| Potash | 3.54 | 3.31 | 3.24 | 3.48 | 3.37 | 3.33 | 3.57 | 3.20 | 3.14 | 3.23 |
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| Average selling price | 39.40 | 38.57 | 38.28 | 36.50 | 36.14 | 35.43 | 34.00 | 34.29 | 34.00 | 33.25 |
| Average valuation by each year's price | 28.97 | 27.91 | 29.63 | 29.85 | 31.33 | 28.54 | 27.62 | 25.39 | 25.37 | 22.76 |
| Per cent. increase of cost over valuation | 36 | 38 | 30 | 22 | 15 | 24 | 23 | 35 | 34 | 46 |
| Valuat'n by '85 prices | 28.97 | 29.44 | 31.48 | 32.80 | 32.28 | 30.36 | 30.77 | 29.10 | 30.29 | 27.19 |
| Valuat'n by '94 prices | 24.23 | 24.53 | 26.54 | 27.30 | 26.59 | 25.08 | 25.44 | 24.19 | 25.05 | 22.76 |

### AVERAGE ANALYSES OF ALL BRANDS.

| | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | 2.38 | 2.58 | 2.75 | 2.80 | 2.55 | 2.41 | 2.52 | 2.42 | 2.41 | 2.21 |
| Soluble Phos. Acid | 6.35 | 6.15 | 5.48 | 6.74 | 6.68 | 5.99 | 6.47 | 6.47 | 6.44 | 5.42 |
| Reverted " " | 1.93 | 1.92 | 3.23 | 2.80 | 2.97 | 2.97 | 2.86 | 2.60 | 2.84 | 2.97 |
| Insoluble " " | 2.13 | 2.59 | 2.52 | 2.56 | 2.98 | 2.71 | 2.00 | 2.18 | 2.34 | 2.16 |
| Available " " | 8.28 | 8.07 | 8.71 | 9.54 | 9.65 | 8.96 | 9.33 | 9.07 | 9.28 | 8.39 |
| Total " " | 10.41 | 10.66 | 11.23 | 12.10 | 12.63 | 11.67 | 11.33 | 11.25 | 11.62 | 10.55 |
| Potash | 2.77 | 2.69 | 2.84 | 3.12 | 2.69 | 3.16 | 3.13 | 2.82 | 2.64 | 2.95 |
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| Average selling price | 37.90 | 37.02 | 36.75 | 35.13 | 35.11 | 34.39 | 33.14 | 32.47 | 32.32 | 31.47 |
| Average valuation by each year's price | 26.72 | 25.75 | 27.15 | 28.96 | 29.05 | 26.70 | 26.07 | 24.48 | 23.53 | 21.47 |
| Per cent. increase of cost over valuation | 42 | 44 | 35 | 21 | 21 | 29 | 27 | 33 | 37 | 47 |
| Valuat'n by '85 prices | 26.72 | 27.21 | 28.86 | 30.88 | 30.03 | 28.52 | 29.16 | 28.22 | 28.46 | 25.84 |
| Valuat'n by '94 prices | 21.89 | 22.49 | 23.87 | 25.36 | 24.33 | 23.19 | 23.85 | 22.99 | 23.09 | 21.47 |

The average compositions, selling prices and valuations of the standard brands are always higher than those of all the brands, and the percentage of increase of cost over valuation less in all but two years. This is caused by the presence of three potato fertilizers in the group of seven brands, they being richer in nitrogen and potash than most brands; and. also, by the presence of low-grade goods in the other table. The smaller percentage of increase of cost over valuation in the case of the standard brands, is an argument in favor of the wisdom of buying goods of an established reputation, and tends to show that in the fertilizer trade, as in others, the best is usually the cheapest.

The percentage of increase of cost over valuation shows a marked decrease from 1885 to 1889, since which time it has increased again. During the last three years this increase has been rapid and it has now arrived at the wide margin of the early eighties. This decrease and increase is also true of the other New England States. It may be explained in part by the effect upon the manufacturers of the establishment of Experiment Stations all over the United States in 1888, and the consolidation of firms and limiting of competition in 1892. It is probable, too, that about 20 per cent is the lowest margin possible to a solvent fertilizer trade, since the low margins of '88 and '89 were followed by the failure of several of the fertilizer firms selling in this State Manufacturers, moreover, are clinging closer to their lower guarantees than formerly.

## COST OF PLANT FOOD, 1885 to 1894.

It appears that the consumer of '88 and '89 was getting the best grade of goods and was paying a less excess over valuation than former or later buyers. In spite of a fall in the prices of mixed goods and a sharp fall in the trade values of fertilizing ingredients the buyer of to-day gets less plant food for the dollar invested than he did six years ago. The buyer in 1894 may purchase at the point of consumption for a dollar, fertilizing ingredients worth 68.2 cents at the seaboard, while in 1888 he bought 72.2 cents worth, and, in 1885, but 57.8 cents worth, *based on the present (1894) trade values.* The plant food which costs a dollar in 1894, cost ninety-four cents in 1888, and one dollar and eighteen cents in 1885. The Vermont consumer never paid less for his plant food than last year (1893). This year (1894) owing to the poorer quality of the fertilizers he is paying higher prices for the same plant food. But if former prices were fair he should now pay *less* now than ever before, because of the sharp fall in the prices of crude phosphate stock since 1891. From 1889 to 1894 the average selling price has fallen $3.64, or 10 per cent, the average valuation, $7.58, or 26 per cent. In other words, the decrease in selling price has not been proportionate to the decrease in the actual cost of crude stock.

This situation has its most hopeful remedy in intelligent buying. The brands sold in the State are almost always equal or nearly equal to their minimum guarantees. It is no fraud in the eye of the law to charge a high price, so long as the guarantee is fulfilled. Other things being equal, the brand which gives the most available plant food for the dollar expended is the best. That there is a choice, is evident from the results of inspection work in this State, and an intelligent study of market conditions, guarantees, selling prices and analyses, will go far towards aiding the consumer in his purchases.

It has been stated already that a dollar in 1894 bought as much plant food as $1.18 in 1885. On the aggregate fertilizer business of the State, this amounts to a large sum. It means that the farmers of this State are saving **$40,000.00** yearly over what the same fertilizers would have cost in 1885. Many influences have combined to produce this result, and there is no doubt but that the work of the Station in sampling, analyzing and publishing the results broadcast over the State has been one of these influences, and by no means the least.

## V. ANALYSES OF WOOD ASHES, ETC.

| Station Number. | Character. | RECEIVED FROM. | Soluble Potash. | Total Potash. | Total Phosphoric Acid. | Lime. | Insoluble Matter. | Cost per ton. |
|---|---|---|---|---|---|---|---|---|
| 1057 | Can.Hd.Wd. | E. O. Lee, Vernon | 6.44 | .... | .... | .... | .... | $10. |
| 1059 | " " " | F. H. Atwood, Westminster | 3.27 | .... | .... | .... | .... | 11. |
| 1061 | " " " | H. D. Rood, Braintree | 7.66 | .... | 1.96 | .... | 8.38 | .... |
| 1063 | " Elm | Sherman & Brady, Newport | 3.62 | .... | .... | 33.10 | 34.93 | 11. |
| 1064 | Lime Kiln | L. H. Felton, Highgate Spr. | 0.43 | 1.93 | ... | 47.00 | 21.60 | .... |
| 1066 | " | Chas. Dole, Northfield | 1.82 | 3.53 | 1.03 | .... | 1.83 | 4. |
| 1067 | " | " " | 0.84 | 2.07 | 1.39 | .... | 2.52 | 4. |
| 1068 | Tan Bark | G. H. Terrill, Morrisville | 1.30 | 2.12 | 1.98 | .... | 5.65 | .... |
| 1069 | " | " " | 1.30 | .... | .... | .... | .... | .... |
| 1137 | Can.Hd.Wd | C. A. Hinsdale, No. Ben'ton | 4.20 | 4.29 | 2.15 | .... | 19.50 | .... |
| 1138 | " " " | " " | 4.72 | 4.92 | 2.14 | .... | 37.00 | .... |
| 1139 | " " " | " " | 4.51 | 4.68 | 2.19 | .... | 8.38 | .... |
| 1140 | Lime Kiln | Albert Willard, Burlington | 0.49 | ... | 1.39 | .... | 2.25 | 3. |
| 1141 | Can.Hd.Wd. | T. L. Johnson, Vernon | 4.90 | ... | 1.66 | .... | 8.00 | 11. |
| 1142 | Lime Kiln | J. P. Rich, Swanton | 2.63 | 4.55 | 1.98 | .... | 8.00 | 6. |
| 1143 | Hard Wood | Albert Willard, Burlington | 5.20 | .... | 1.85 | .... | 19.25 | 18. |
| 1144 | Lime Kiln | " " | 1.91 | 3.99 | 1.38 | .... | 7.00 | 4. |
| 1148 | Can.Hd.Wd | O. J. Lowrey, Jericho | 3.66 | 4.31 | 1.06 | .... | 4.38 | 11. |
| 1149 | S.Wd.&Coal | Albert Willard, Burlington | 0.95 | 2.82 | ... | .... | 67.40 | .... |

### ANALYSES OF MUCK AND TANKAGE.

| Station Number. | RECEIVED FROM. | Moisture. | Ash. | Volatile and Organic. | Nitrogen. | Nitrogen Soluble in Pepsin. | Per cent of Available Nitrogen. |
|---|---|---|---|---|---|---|---|
| 1058 | Muck—L. W. Peet, Cornwall | 25.58 | 23.63 | 50.79 | 2.49 | .... | .... |
| 1062 | Muck—M. A. Maynard, Burlington | 81.21 | .... | ... | 0.76 | .... | .... |
| 1065 | Muck—E. G. Tuthill, Waterbury | 36.46 | ... | .... | 1.72 | .... | .... |
| 1060 | Philadelphia Tankage | .... | .... | .... | 9.62 | 3.79 | 39 |

# 1894.

# VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 42.

JULY, 1894.

## Bovine Tuberculosis.

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BURLINGTON:
FREE PRESS ASSOCIATION,
1894.

# ORGANIZATION.

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☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

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# BULLETIN NO. 42.—BOVINE TUBERCULOSIS.

BY J. L. HILLS AND F. A. RICH, V. S., M. D.

## I. SUMMARY.

II. Tuberculosis was discovered in the Station herd in January last by means of the tuberculin test. But two cows were out of condition, yet twenty-four animals reacted at this and subsequent tests. The infected animals were killed, and the post-mortems confirmed the test throughout, while two animals which did not react showed no disease upon slaughter. The distribution of the disease was: Lungs, 90 per cent. udder and its glands, 78 percent. intestines and mesenteric glands, 50 per cent. Physical examination alone did not detect disease in several cases. Six of the cattle were bought from herds which we now believe were affected with tuberculosis. The disease was located at each end of the barn. The barn was disinfected by burning sulphur and by spraying a diluted solution of corrosive sublimate over the wood work. All the wood about the mangers was replaced. Eighteen grade Jerseys were bought in April from seven different herds, subject to the tuberculin test. All were found free from disease. It is intended hereafter to periodically test the Station herd with tuberculin. (Pages 21-30.)

III. The Station Veterinarian has this year made over a thousand injections of tuberculin, mostly in this State. 222 animals were found diseased, 220 were slaughtered and found tuberculous. Omitting two badly infected Vermont herds but 89 animals were tuberculous out of 662 tested, in 81 different herds. These figures should not be taken as indicating the prevalence of the disease in this State for injections were made mainly in suspected herds.. The distribution of the disease in 189 post-mortems showed 82 per cent. in the lungs, 22 per cent. in the mesenteric glands and 24 per cent. in the udder. (Pages 30-31.)

IV. 1. PREVALENCE AND HISTORY.—Tuberculosis is the general name for a class of diseases which attack various organs and which both man and animal readily contract. The human death rate from all forms of the disease is about one in four. Cattle are affected in various proportions in different parts of the world. The extent of bovine tuberculosis in this country cannot be accurately stated owing to the lack of

The manuscript of this Bulletin was read by the Director of the Station at a joint meeting of the State Board of Agriculture (acting as Cattle Commissioners) and the Board of Control of the Station, and its subject matter was freely discussed. The proofsheets were submitted to the Governor and to the individual members of each Board for their comments and criticisms.

We are pleased to endorse the Bulletin as being, in our opinion, a conservative statement of the present knowledge of the causes, prevalence and means of detection and prevention of tuberculosis.

STATE BOARD OF AGRICULTURE,
by C. M. WINSLOW, Secretary.

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2. CAUSE.—The sole and exciting cause of this disease is a germ called the bacillus tuberculosis. It is a parasitic, microscopic, rod-shaped plant which lives in the animal body, has great vitality, resists heat, cold, moisture, drought, decay and often the process of digestion. It is killed by boiling, by long continued heat at from 150 to 170°, as well as by sunlight, air and certain chemicals. Infection occurs (1) By breathing the germs; (2) By swallowing the germs; (3) By their entrance through a cut or wound. The main sources of infection are: (1) The dust of the dried spittle of consumptives or other tuberculous matter, either breathed or swallowed; (2) Contact with tuberculous material or people; (3) The meat and milk of tuberculous animals. (Pages 33-36.)

3. ACCESSORY CAUSES.—The bacillus tuberculosis is the sole cause of the disease, but there are conditions so favorable to its development that they are well termed accessary causes, although strictly speaking they are not causal. Among these conditions are: (1) Hereditary predisposition; (2) Unhealthy surroundings, poor ventilation, uncleanly, dark, damp, hot and cold stabling, soiling system, lack of exercise, climatic influences; (3) Faulty feeding, under feeding, over feeding, feeding on unwholesome or indigestable materials, over production; (4) Faulty

breeding, in and inbreeding, early, late and frequent breeding, intensive; breeding, lack of constitution; (5) Ill-health, temporary predisposition (6) Physical constitution. (Pages 36-41.)

4. SYMPTOMS.—The symptoms of bovine tuberculosis are more obscure than those of the human disease, and often baffle detection. Any attempt to describe them would probably prove misleading rather than instructive. (Page 41.)

5. LESIONS. Wherever the germs locate in the body they irritate the tissue, forming round nodular masses. These newly formed tubercles are usually soft and red. In chronic cases they become cheesy, limy, and disintegrate and run together, forming yellowish, caseous, pus-containing masses of various sizes imbeded in the diseased organs. The lungs, linings of the chest and abdomen, the lymphatic glands and the bowels are most often diseased. Sometimes the tubercles are too small for the naked eye to see. (Pages 42-45.)

6. THE TUBERCULIN TEST.—Tuberculin is made from pure cultures (growth separate from all other germs) of the tubercle bacillus, concentrated, sterilized (to kill all germ life) and filtered. It contains the chemical poisons created by the life functions of the germs. Although a failure as a cure for tuberculosis, it has been successfully used to detect its existence in cattle. If a small quantity is injected into a tuberculous animal it will produce a fever, but, if the animal is healthy and it is properly used there should be no rise of temperature. An increase of two degrees above the normal temperature after injection is ground for suspicion. The tuberculin test is not infallible. Mistakes have been made in its use, and it has sometimes failed in careful hands. It is, however, much more reliable than any other known means of diagnosis. If properly made and used, it cannot cause tuberculosis. (Pages 45-51.)

7. INTER-RELATION.—Both human and bovine tuberculosis are infectious. Human tuberculosis affects the lower animals, and bovine tuberculosis affects man. The latter has never been directly proved, but many cases of accidental infection have demonstrated its possibility. It has been claimed that tuberculosis does not exist where there are no cattle, and that tuberculous infection was originally of bovine origin. Experiments have shown that the disease producing germ may be present in the milk whether the udder is affected or not. If milk is sterilized by heat, or "pasteurized," it may be considered safe to use. It has recently been claimed that, because of the alleged presence of tuberculin in tuberculous milk, even though sterilized, there is danger to its consumers of aggravation of the disease if already present. It is not advisable to attempt to cure bovine tuberculosis. (Pages 51-61.)

8. PREVENTION.—Both human and bovine tuberculosis are preventable, and the means which may be taken to prevent its spread are: (1) Official inspection of cattle, meat and milk; (2) The destruction or disinfection of human spittle; (3) Careful disinfection of places occupied by tuberculous men or animals. The stock owner, so far as possible, should keep his cattle under healthy conditions, should keep each animal in its own stanchion, should isolate suspected animals, should buy cautiously, should exclude human and animal consumptives from the barn, should test newly admitted animals, and, if he finds the disease, should kill, bury or burn the diseased animals, disinfect the premises and test the rest of the herd. (Pages 61-62.)

9. RELATION OF THE STATE TO TUBERCULOSIS.—The most successful work in the suppression of animal disease is that done by the Government, since it is accomplished in a systematic, intelligent and thorough manner. The New England, Middle and some of the Western States exercise a control over animal diseases by means of Cattle Commissions. Some State laws permit indemnity, others do not. Attention is called to the statement and bond of the Vermont Commission on pages 66-68 of this bulletin. (Pages 63-68.)

## II. TUBERCULOSIS IN THE EXPERIMENT STATION HERD.

Dairying has always been a prominent feature of the work of this Station. Beginning in June, 1888, with six cows, the Station herd was increased by purchase and by breeding until at the opening of the current year it consisted of thirty-three head, including three bulls, twenty-four cows, one yearling and five calves. There were twenty-one Jerseys (five registered), six Ayrshires (four registered) and six Holsteins (five registered) in the herd. The sixteen unregistered Jerseys were mostly high grades. Ten of the cows were members of the herd of the summer of 1891, seven were bought that fall, and seven, together with the three bulls, were bought later.

The herd records for 1892* and 1893† were very satisfactory. In 1892 the twelve regular members of the herd averaged 351 pounds of butter per cow, while in 1893, the fifteen regular members average 341 pounds of butter per cow. If the irregular members of the herd are included these averages are reduced to 334 pounds for 1892 and 311 pounds for 1893. The decrease in the production of 1893 was partly due to abortion and sterility, possibly of tubercular origin. The herd was a good working dairy, such as is within the means of most dairymen. It was collected without large outlay, only four of the cows costing over one hundred dollars. We hoped to obtain good butter yields by care and feed rather than by buying costly stock.

At New Year's the entire herd seemed to be in prime condition, with the exception of the registered Jersey cow LaViolette 3rd, 62,543 A. J. C. C. and the registered Holstein cow Mercedes Jonkje, 18,346 H. F. H. B. These two cows began to appear unthrifty on coming in from pasture in the late fall. The Jersey coughed somewhat. The Station Veterinarian made a physical examination of the two cows and diagnosed either acute bronchitis or tuberculosis. A general physical examination of the other cattle indicated the presence of considerable lung disease, and it was decided to use Koch's test (injection of Koch's lymph or tuberculin) upon the entire herd.

The detection of tuberculosis in its earlier stages by external signs is usually impossible. Unless the lesions are in the lungs, even advanced cases are hard to detect. An animal in this condition may be sleek, fat and frisky, may give large amounts of apparently normal milk, and yet may be infecting other stock as well as those using her milk. It is obviously desirable to be able to detect the presence of this disease in any stage, early or late, wherever its location, without injury to the healthy animal. The means for such detection have been found in the fluid known as Koch's lymph or tuberculin, a preparation first discovered in 1889 by the famous German scientist, Dr. Koch. He vainly hoped it might prove a cure for tuberculosis. Although a failure as a remedy, it is rapidly coming into use for diagnostic purposes in veterinary practice.

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* See Sixth Annual Report, page 120; also Bulletin No. 33; also Seventh Annual Report, now in press.

† See Seventh Annual Report, now in press.

The "test" is made as follows:

(1) The normal temperature of the animal is taken.

(2) A small quantity of dilute lymph is injected under the carefully disinfected skin near the shoulder blade.

(3) The temperature of the animal is taken at intervals of from one to three hours, beginning with the sixth hour from the time of injection and continuing until the sixteenth to twenty-fourth hour.

If an animal is tuberculous, a decided rise of temperature or temporary fever is observed, usually in from six to fourteen hours. Although not infallible, this test is much the most reliable test we now have. *It should be used only by skillful veterinarians, since the precautions necessary are not such as the farmer is prepared to observe.**

The tuberculin used in the test at the Experiment Station was procured from the Bureau of Animal Industry of the Department of Agriculture at Washington. The injections were made by the Station Veterinarian and the temperatures taken under his direction.

The twenty-four cows were injected December 31, between ten and twelve p. m., the temperature of each cow was taken at the time of injection and hourly on the day following from 8 A. M. to 11 P. M., and again January 5, from 8 A. M. to 12 P. M. The amount of tuberculin used per animal were: Bulls, 3 c. c.; cows, 2 to 2.5 c. c.; yearling, 1.5 c. c.; calves, 0.75 c. c.

The following table shows in detail the temperature observations on each of the thirty-three animals. The normal temperatures occupy the upper lines, and those taken after injection, the lower line. The temperatures indicating reaction are put in black faced type. The following cows did not react: Bonnie, Blossom, Dinah, Gretchen, Josie, Minerva and Rena Myrtle. They were driven to an uninfected barn. Dorothy and Lolita showed single temperatures above 104° and were isolated in the veterinary hospital. On March 25th, eight of these cows were again tested, and one, Bonnie, reacted. The second test is entered in the table in each case below the first test. Bonnie was tested a third time, June 28, and again reacted.

As will be seen on reference to the table, the three bulls, sixteen cows, the yearling and one calf, a total of twenty-one animals, being nearly three quarters of the adult herd, reacted to tuberculin. Fifteen of these showed physical signs of lung disease; two others had bronchitis.

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*For more extended explanation of the detection of tuberculosis and the use of tuberculin see pages 41 to 51.

‡This board is also the State Cattle Commission.

## RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS.

| | 8 A. M. | 9 A. M. | 10 A. M. | 11 A. M. | 12 M. | 1 P. M. | 2 P. M. | 3 P. M. | 4 P. M. | 5 P. M. | 6 P. M. | 7 P. M. | 8 P. M. | 9 P. M. | 10 P. M. | 11 P. M. | Average Normal. | Highest Normal. | Highest Test Temperature. | Rise of Highest Test above Average Normal. | Rise of Highest Test above Highest Normal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Louis Lambert, 25371 | 100.5 | 101.5 | 101. | 100.5 | 101. | 100.5 | 100.8 | 100.5 | 100.8 | 100.5 | 100.5 | | | | | | | | | | |
| | 103.5 | 103. | **104.** | **105.** | **105.5** | **105.5** | **105.5** | **105.** | **105.5** | **105.** | **105.3** | **104.5** | **104.** | 103.8 | | | 100.7 | 101.5 | **105.5** | **4.8** | **4.0** |
| 2. Beauty | 102. | 102. | 101.4 | 101.6 | 101.6 | 102. | 102. | 101.6 | 101.6 | 101.8 | | 101.5 | | 101.5 | | 100.5 | | | | | |
| | 101.8 | 102.8 | 102.6 | 103.5 | **105.5** | **106.3** | **106.3** | **105.3** | **106.5** | **105.6** | **105.4** | **105.4** | **105.2** | **104.8** | **104.** | 103. | 101.6 | 102. | **106.5** | **4.9** | **4.5** |
| 3. Blossom | 102. | 101.8 | 101.5 | 101.8 | 101.5 | 101.5 | 101.6 | 101.8 | 101.6 | 101.6 | | 100.8 | | 100.8 | | 100.8 | | | | | |
| | 102.2 | 101.8 | 102. | 101.8 | 102. | 101. | 101. | 101.5 | 102. | 102. | 101.6 | 101.5 | 101. | 101. | 101. | 101. | 101.5 | 102. | 102.2 | 0.7 | 0.2 |
| Blossom | 100. | | 100.6 | | 101.5 | | 100.2 | | 100. | | 101.5 | | 100.5 | | 101.5 | | | | | | |
| | 101.2 | | 101.4 | | 102.5 | | 102.2 | | 102.2 | | 102. | | 102.5 | | 100.8 | | 100.7 | 101.5 | 102.5 | 1.8 | 1.0 |
| 4. Bright Eyes | 102.4 | 101.5 | 101.8 | 102. | 102.4 | 103. | 102.3 | 102.6 | 102.8 | 102.4 | | 101.5 | | 102.6 | | 100.2 | | | | | |
| | 103. | 102.6 | 102.5 | 102.2 | 102. | 103.6 | **104.8** | **104.5** | **105.** | **104.** | 103.8 | **104.** | **104.** | **104.** | 103.5 | 103.2 | 102.1 | 103. | **105.** | **2.9** | **2.0** |
| 5. Dorothy | 101. | 102. | 101.6 | 102. | 102.2 | 102.2 | 102. | 102.5 | 102.2 | 102.2 | | 101.2 | | 102. | | 102. | | | | | |
| | 102.5 | 103.2 | 102.6 | 102.4 | 102.2 | 102. | 102.8 | 102.8 | 103. | 103.3 | **104.2** | 103. | 103. | 103. | 102.5 | 102.5 | 102. | 102.5 | **104.2** | 2.2 | 1.7 |
| Dorothy | 101. | | 100.6 | | 101. | | 101. | | 101. | | 101.2 | | 101.5 | | 102.2 | | | | | | |
| | 102.5 | | 102.5 | | 101.5 | | 101.5 | | 102.3 | | 102.5 | | 102. | | | | 101.2 | 102.2 | 102.5 | 1.3 | 0.3 |
| 6. Floss | 102.6 | 102.4 | 101.5 | 102. | 102.2 | 102. | 102.5 | 102.4 | 102.2 | 102. | | 102.2 | | 102.2 | | 102. | | | | | |
| | 103.8 | 103.8 | **104.8** | **104.8** | **105.6** | **105.2** | **108.5** | **106.8** | **107.** | **106.** | **106.** | **106.** | **106.** | **105.5** | **105.** | **104.** | 102.2 | 102.6 | **107.** | **4.8** | **4.4** |
| 7. Gretchen | 100.5 | 101. | 101. | 101.2 | 101. | 101. | 101. | 101. | 101. | 101. | | 101. | | 101. | | 101. | | | | | |
| | 101.8 | 102. | 102. | 101.8 | 101.8 | 102. | 102. | 102. | 101.5 | 102.5 | 102.5 | 103.3 | 102. | 102. | 102. | 101.5 | 101. | 101.2 | 102.5 | 1.5 | 1.3 |
| Gretchen | 100. | | 101. | | 101. | | 101. | | 101. | | 101. | | 101.2 | | 100.2 | | | | | | |
| | 101.6 | | 101. | | 100.8 | | 100.4 | | 100. | | 100.2 | | 100.8 | | 100. | | 100.8 | 101.2 | 101.6 | 0.8 | 0.4 |

## RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS.

| | 8 A. M. | 9 A. M. | 10 A. M. | 11 A. M. | 12 M. | 1 P. M. | 2 P. M. | 3 P. M. | 4 P. M. | 5 P. M. | 6 P. M. | 7 P. M. | 8 P. M. | 9 P. M. | 10 P. M. | 11 P. M. | Average Normal. | Highest Normal. | Highest Test Temperature. | Rise of Highest Test above Average Normal. | Rise of Highest Test above Highest Normal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8. Josie | 101.6 | 101.6 | 101.6 | 101.2 | 101. | 101.2 | 101.2 | 101.5 | 101.1 | 101.6 | | 101.2 | | 101.3 | | 100.8 | | | | | |
| | 101.2 | 102.6 | 101.2 | 101. | 101.5 | 101.5 | 101.8 | 101.8 | 102. | 101.2 | 101.6 | 101.2 | 101.2 | 102.5 | 101.8 | 101.0 | 101.3 | 101.6 | 102.6 | 1.3 | 1.0 |
| Josie | 99.4 | | 99.2 | | 100.5 | | 101. | | 101.6 | | 101.4 | | 99.8 | | 101.2 | | | | | | |
| | 101. | | 101.4 | | 101.8 | | 101.5 | | 101. | | 101.4 | | 102.0 | | 101.0 | | 100.5 | 101.6 | 102. | 1.5 | 0.4 |
| 9. La Violette, 3d, 62,543 | **104.** | **104.** | **104.** | **104.** | 103.6 | **104.** | **104.** | **104.2** | **104.4** | **104.1** | | 103.5 | | 103.6 | | 103.0 | | | | | |
| | **104.5** | **105.** | **105.** | **105.** | **104.4** | **105.** | **104.8** | **104.8** | **104.2** | 103.2 | 103.2 | 102.6 | 102.8 | 102.5 | 102.5 | 103.0 | 103.4 | **104.4** | **105.** | 1.6 | 0.6 |
| 10. Marguerite | 101.6 | 101.8 | 101.6 | 101.5 | 102. | 103. | 102. | 101.8 | 102. | 102. | | 101.8 | | 101.5 | | 100.5 | | | | | |
| | 102. | 102.6 | 102. | 102. | 103.4 | 102.5 | 102. | 103. | 103.5 | **104.** | **104.** | **104.8** | **104.** | **104.5** | 104.0 | **104.** | 101.8 | 103.0 | **104.8** | **3.** | 1.8 |
| 11. Marburi 2d, 65,043 | 101.5 | 101.6 | 101.6 | 101. | 101. | 101.5 | 101.6 | 101.2 | 101.6 | 101.6 | | 101. | | 101.2 | | 100.0 | | | | | |
| | 101.4 | 101. | 102. | 102.4 | 103. | **104.5** | **105.8** | **105.5** | **104.5** | 103. | 102. | 101.5 | 101.4 | 101.0 | 101.4 | 102.6 | 101.3 | 101.6 | **105.8** | **4.5** | **4.2** |
| 12. Martha | 101.8 | 101.6 | 101.6 | 101.5 | 101.5 | 101.5 | 102. | 101.5 | 101.5 | 101.4 | | 101.6 | | 101.4 | | 100.2 | | | | | |
| | 101.5 | 101.6 | 102. | 101.4 | 102. | 102.2 | 103.3 | 103.3 | **106.5** | **105.6** | **105.4** | **105.4** | **105.2** | **104.8** | 104.0 | 103.0 | 101.5 | 102.0 | **106.5** | **5.** | **4.5** |
| 13. Minerva | 101.5 | 101.5 | 101.6 | 101.6 | 101.4 | 101. | 101. | 102. | 101.6 | 101.6 | | 101. | | 101.0 | | 100.2 | | | | | |
| | 100.2 | 100.8 | 100.5 | 101. | 101.4 | 101.5 | 101.5 | 101. | 101.3 | 101.5 | 101.5 | 101.5 | 101.5 | 101.5 | 102.0 | 101.5 | 101.3 | 102.0 | 102.0 | 0.7 | 0.0 |
| Minerva | 98.6 | | 99. | | 99. | | 99.8 | | 100.8 | | 99.4 | | 98.5 | | 100.2 | | | | | | |
| | 100.5 | | 100.4 | | 101.2 | | 102.5 | | 101.8 | | 102.5 | | 102.2 | | 100.4 | | 99.4 | 100.8 | 102.5 | **3.1** | 1.7 |
| 14. Myrtle | 101.5 | 101.5 | 101.4 | 101.4 | 101. | 101. | 101.4 | 101.4 | 101.6 | 102. | | 101. | | 101.5 | | 100.8 | | | | | |
| | 102. | 102.4 | **104.** | 106.2 | **107.** | **107.** | **107.** | **107.** | **106.8** | **105.2** | **105.** | **105.8** | **105.5** | **105.** | **105.** | **104.2** | 101.3 | 102.0 | **107.** | **5.7** | **5.** |
| 15. Nancy | 101.5 | 101.6 | 101. | 101. | 101.2 | 101. | 101.2 | 101.2 | 101.2 | 101.4 | | 101. | | 101.8 | | 100.2 | | | | | |
| | 102.5 | 102. | 101.5 | 102. | 102.6 | **104.** | **104.8** | **104.5** | **105.** | **105.4** | **105.2** | **105.5** | **105.5** | **104.** | 103.5 | 103.8 | 101.1 | 101.6 | **105.5** | **4.4** | **3.9** |
| 16. Sadie's Delight, 53,392 | 101.2 | 101.2 | 101. | 101. | 101.2 | 101. | 101. | 101. | 101. | 101.2 | | 101.8 | | 102.8 | | 100.8 | | | | | |
| | 101. | 103.8 | **104.6** | **107.5** | **107.4** | **106.8** | **105.5** | **105.5** | **105.5** | 103. | 102.6 | 103. | 102.5 | 102.5 | 102.0 | 101.5 | 101.2 | 102.8 | **107.5** | **6.3** | **4.7** |

## RECORDS OF TUBERCULIN TEST, STATION HERD, JERSEYS AND AYRSHIRES.

| | | 8 A. M. | 9 A. M. | 10 A. M. | 11 A. M. | 12 M. | 1 P. M. | 2 P. M. | 3 P. M. | 4 P. M. | 5 P. M. | 6 P. M. | 7 P. M. | 8 P. M. | 9 P. M. | 10 P. M. | 11 P. M. | Average Normal. | Highest Normal. | Highest Test Temperature. | Rise of Highest Test above Average Normal. | Rise of Highest Test above Highest Normal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. | Ethel | 101.4 | 101.5 | 101.4 | 101.8 | 101.6 | 102. | 101.6 | 102.2 | 102. | 101.8 | 101.6 | 102. | 102. | 101.8 | 101.8 | | | | | | |
| | | 101.5 | 102.2 | 102.6 | 103.4 | **104.4** | **105.** | **105.2** | **105.2** | **104.6** | **104.** | 103.2 | | | | | | 101.8 | 102.2 | **105.2** | **3.4** | **3.** |
| 18. | Calf 1 | 101.8 | 101.5 | 102.5 | 102. | 101.5 | 101.3 | 101.5 | 102. | 102. | 102.5 | 102.5 | | | | | | | | | | |
| | | 102.5 | 102. | 102.3 | 102.3 | 101.5 | 102. | 102.3 | 102. | 102.5 | 102. | 102. | 101.5 | 101.3 | 101. | 101. | | 101.9 | 102.5 | 102.5 | 0.6 | 0.0 |
| 19. | Calf 2 | 101.5 | 101.8 | 101.5 | 102. | 102.5 | 102. | 101.8 | 102. | 101.8 | 102.2 | 102.5 | | | | | | | | | | |
| | | 102.5 | 102.3 | 103. | 102.3 | 102. | 102. | 102. | 102.5 | 102.3 | 101.8 | 101.5 | 102. | 101.5 | 101.3 | 102.5 | | 102. | 102.5 | 103. | 1.0 | 0.5 |
| 20. | Calf 3 | 101. | 101. | 101.5 | 101.5 | 102.3 | 102.5 | 102.5 | 102. | 102. | 102.8 | 102.8 | | | | | | | | | | |
| | | 101.5 | 102.5 | 103.8 | 102.5 | **104.** | **104.** | **104.** | 103.2 | 103.3 | 103. | 103. | 103.5 | 103. | 102.5 | 102. | | 102. | 102.8 | **104.** | **2.0** | 1.2 |
| 21. | Calf 5 | 101.3 | 101.3 | 101. | 101.5 | 101.3 | 101.5 | 101.5 | 101.5 | 101.5 | 101.8 | 102. | | | | | | | | | | |
| | | 103. | 102.5 | 102.8 | 102.6 | 102.8 | 103. | 102. | 102.5 | 102.5 | 103. | 102. | 103. | 101.8 | 101.8 | 101.8 | | 101.5 | 102. | 103. | 1.5 | 1.0 |
| 22. | Rubinor, 4676. | 100.8 | 100.5 | 100.5 | 101. | 100.8 | 101.3 | 101.5 | 101.5 | 101.5 | 101. | 100.8 | | | | | | | | | | |
| | | 101. | 101. | 101.8 | 101.8 | 102.5 | 103. | **104.** | **105.5** | **106.** | **106.** | **106.** | **105.5** | **105.** | **104.5** | 103. | 103. | 101. | 101.5 | **106.** | **5.0** | **4.5** |
| 23. | Bonnie | 101.5 | 101.6 | 101.4 | 101.5 | 101.4 | 101.5 | 101. | 101. | 101.2 | 101.4 | | 101. | | 102. | | 100.8 | | | | | |
| | | 102.2 | 101.5 | 101.8 | 101.5 | 101.6 | 103. | 102.3 | 102.2 | 103. | 103. | 102. | 102.8 | 103.5 | 103.5 | 103.3 | 103.5 | 101.3 | 102. | 103.5 | **2.2** | 1.5 |
| | Bonnie | 98.6 | | 101.1 | | 101. | | 100.8 | | 99.6 | | 101.5 | | 101. | | | | | | | | |
| | | 100.6 | | **104.4** | | **106.** | | **105.9** | | **105.2** | | 103.8 | | **105.** | | **104.5** | | 100.5 | 101.5 | **106.** | **5.5** | **4.5** |
| 24. | Creamer | 102. | 103. | 103.2 | 102.5 | 102.6 | 102.5 | 101.5 | 101.5 | 102.5 | 102. | | 102. | | 102. | | 100.8 | | | | | |
| | | 103.5 | 103.5 | 103.6 | **104.2** | 103. | **106.** | **106.6** | **107.** | **107.3** | **107.** | **106.8** | **105.5** | **105.3** | **105.** | **104.8** | **104.8** | 102.2 | 103.2 | **107.3** | **5.1** | **4.1** |
| 25. | Lolita, 9465 | 102.5 | 103. | 102.8 | 103. | 103. | 103. | 103.5 | 103.2 | 103.4 | 103.2 | | 100. | | 100. | | 100. | | | | | |
| | | 102.5 | 102.8 | 102.8 | 102.8 | 102.8 | 103.2 | 103.4 | 102.8 | 103.5 | **104.5** | 103. | 103.5 | 103.6 | 103.5 | 103.3 | 103.3 | 102.4 | 103.5 | **104.5** | **2.1** | 1.0 |
| | Lolita, 9465 | 101. | | 101.8 | | 101.8 | | 101. | | 101.2 | | 101. | | 102.2 | | 100.6 | | | | | | |
| | | 102.5 | | 102.5 | | 101.5 | | 101.5 | | 101.8 | | 102.5 | | 102.5 | | | | 101.3 | 102.2 | 102.5 | | 0.3 |

## RECORDS OF TUBERCULIN TEST, STATION HERD, AYRSHIRES AND HOLSTEINS.

| | 8 A. M. | 9 A. M. | 10 A. M. | 11 A. M. | 12 M. | 1 P. M. | 2 P. M. | 3 P. M. | 4 P. M. | 5 P. M. | 6 P. M. | 7 P. M. | 8 P. M. | 9 P. M. | 10 P. M. | 11 P. M. | Average Normal. | Highest Normal. | Highest Test Temperature. | Rise of Highest Test ab ove Average Normal. | Rise of Highest Test above Highest Normal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26. Rena Myrtle, 9530. | 102.2 | 102.6 | 102.5 | 101. | 102. | 101.6 | 101.7 | 101.6 | 101.6 | 101.6 | | 101. | | 101. | | 100.5 | | | | | |
| | 102. | 102.2 | 102.2 | 102.5 | 102. | 102. | 101.8 | 102. | 102. | 102. | 101.8 | 101.8 | 101.8 | 101.8 | 101.3 | 101.3 | 101.7 | 102.6 | 102.5 | 0.8 | -0.1 |
| Rena Myrtle, 9530. | 101.5 | | 101.6 | | 101.8 | | 100.8 | | 100.4 | | 101.6 | | 100.8 | | 101.4 | | | | | | |
| | 101.2 | | 102.2 | | 102.2 | | 102. | | 101.5 | | 101.8 | | 102. | | 101.6 | | 101.2 | 101.8 | 102.2 | 1.0 | 0.4 |
| 27. Calf 4...... | 102.8 | 102.5 | 102. | 102.8 | 102. | 102. | 102. | 102. | 102. | 102.5 | 102.5 | | | | | | | | | | |
| | 103. | 102.5 | 102.8 | 102.5 | 102.8 | 102.5 | 102.8 | 102.5 | 102.8 | 102.3 | 102. | 102. | 102. | 102. | 101.8 | | 102.3 | 102.8 | 103. | 0.7 | 0.2 |
| 28. Marmion.... | 101. | 101. | 101. | 100.8 | 101.3 | 100.5 | 101.5 | 101. | 101. | 101.3 | 101.3 | | | | | | | | | | |
| | **106.5** | **106.** | **106.** | **106.5** | **105.8** | **105.8** | **105.5** | **105.5** | **105.5** | **106.** | **106.3** | **106.** | **106.** | **106.** | **105.** | | 101.1 | 101.5 | **106.5** | **5.4** | **5.0** |
| 29. Cigarette, 3886. | 102.4 | 102.2 | 102.2 | 101.6 | 102. | 102.2 | 102. | 101.6 | 101.5 | 102. | | 101.2 | | 102. | | 101.5 | | | | | |
| | 103. | 103. | 103.5 | 103.5 | **104.5** | **104.5** | **105.5** | **106.** | **106.** | **105.3** | **105.** | **105.** | **104.3** | **104.** | **104.** | 103. | 101.9 | 102.5 | **106.** | **4.1** | **3.5** |
| 30. Cloverette, 23286. | 102. | 102.2 | 102. | 102. | 101.6 | 102. | 102. | 102. | 101.8 | 102. | | 101.4 | | 102. | | 101.2 | | | | | |
| | 102. | 102.5 | 103.6 | 103.5 | **104.** | **104.5** | **105.5** | **196.8** | **106.5** | **107.** | **106.** | **106.3** | **106.** | **106.** | **105.3** | **104.5** | 101.9 | 102.2 | **107.** | **5.1** | **4.8** |
| 31. Dinah...... | 102. | 102. | 101.8 | 102.5 | 102. | 103. | 102.5 | 102.5 | 102.2 | 102.4 | | 102.6 | | 102.4 | | 100.8 | | | | | |
| | 102. | 102. | 102.5 | 103. | 102.8 | 103.5 | 103.2 | 102.5 | 103. | 103. | 103.4 | 102.2 | 103. | 102.5 | 103. | 102.4 | 102.2 | 103. | 103.5 | 3.1 | 0.5 |
| 32. Mercedes Jonkje, 18346. | 102. | 102. | 102.2 | 102.2 | 102.5 | 102. | 102. | 102. | 102. | 102.2 | | 102. | | 102. | | 102. | | | | | |
| | 102.2 | 103. | 103.6 | 103.8 | 103.8 | **106.** | **105.8** | **106.2** | **106.2** | **106.5** | **104.5** | **104.4** | **104.5** | **104.** | **104.** | 103.5 | 102.1 | 102.5 | **106.5** | **4.4** | **4.0** |
| 33. Pipchin 2d, 1483. | 102. | 102. | 102.2 | 101.5 | 101. | 101. | 101. | 101.5 | 101. | 101. | | 101. | | 101. | | 100.8 | | | | | |
| | 103.5 | 103 6 | **105.** | **107.** | **107.5** | **107.5** | **107.8** | **106.5** | **106.5** | **105.8** | **103.6** | **104.** | 103.6 | **104.** | **104.** | 103.6 | 101.3 | 102.2 | **107 8** | **6.5** | **5.6** |

1-21 Jerseys, 22-27 Ayrshires, 28-33 Holsteins. Registered animals have registered numbers attached. 18, 27 and 28 were eligible to registry.

The Board of Control of the Station were notified at once, and all sales of farm dairy products were stopped. After a thorough discussion of the situation, and after consultation with Dr. J. H. Hamilton, President of the State Board of Health, the State Board of Agriculture‡, Hon. Z. A. Gilbert of Maine and Hon. A. W. Cheever of Massachusetts, Ex-members of the Cattle Commissions of their respective States, and Dr. Frank H. Miller, V. S., of Burlington, the Board of Control ordered the slaughter of three cows, La Violette 3d, Mercedes Jonkje and Creamer. The two former were manifestly out of conditon, while Creamer was in as fine flesh as any cow in the herd.

The post-mortems were conducted in the presence of the above named officials, and Dr. H. A. Crandall, City Health Officer, by the Station Veterinarian, assisted by Drs. F. H. and G. A. Miller, veterinary surgeons. LaViolette and Mercedes were plainly and badly tuberculous, the evidence being clear to the naked eye. Creamer's udder contained miliary tubercles, which upon microscopic examination showed the characteristic bacteria (bacillus tuberculosis). Later developments showed that the lesions in her case were more obscure than those of any other animal killed in the herd.

The rest of the cattle reacting to the lymph were killed, and post-mortems made. In every case the prediction of the tuberculin was verified. Two calves (Nos. 2 and 5) which did not react were killed and examined with scrupulous care, but no evidences of the disease were found.

The lesions found in the animals killed were, briefly, as follows :

1. JERSEYS—*Bull: Louis Lambert*;* lung contained caseous masses; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; left testicle calcareous.

2. *Cows: Beauty*;* apex one lung, caseous, calcareous; bronchial and post-pharyngeal glands enlarged, caseous, calcareous.

4. *Bright Eyes**, Bronchial and post-pharyngeal glands greatly enlarged, caseous; liver and capsule tubercular; supermammary glands tubercular.

6. *Floss*;* lung contained caseous masses extending well into parenchyma; bronchial and post-pharyngeal glands enlarged, caseous.

9. *La Violette**;* lungs consolidated, outer surface mottled, section showed pus cavities, caseous; pleura and pleural side of diaphragm thickly studded with tubercles; bronchial, mesentric and lymphatic glands in general tubercular, caseous. Apparently an acute form of tuberculosis.

10. *Marguerite*;* apex lung caseous; bronchial, post-pharyngeal and supermammary glands tubercular.

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* Physical signs of lung disease.

** Bronchitis and unthriftiness.

11. *Marburi 2d*;* post-pharyngeal glands tubercular; supermammary glands enlarged and tubercular; indurated mass in right fore quarter.

12. *Martha*;* bronchial, mesenteric and supermammary glands tubercular; peritoneum over uterus contained tubercles.

14. *Myrtle*;* lungs contained large caseous masses; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; supermammary glands enlarged, tubercular.

15. *Nancy*;* Pleurisy with adhesions; bronchial, post-pharyngeal and mesenteric glands tubercular.

16. *Sadie's Delight*;* lungs contained pus and caseous masses; plastic pleuritis with adhesions; bronchial and post-pharyngeal glands enlarged, caseous, calcareous; supermammary and mesenteric glands tubercular.

17. *Yearling, Ethel;* post-pharyngeal glands enlarged, caseous, calcareous; miliary tubercles on mesentery.

20. *Calf No. 3*, (2½ months old); lungs contained caseated tubercular nodules; bronchial and mesenteric glands tubercular. This calf, with four others, had been fed on skimmilk from Station herd. Its mother (Josie) did not react to tuberculin.

22. AYRSHIRES—*Bull: Rubinor*; apex one lung caseous; bronchial and post-pharyngeal glands enlarged, caseous.

23. *Cows—Bonnie;* passed first injection; gave reaction on second and third tests; lungs and lymphatic glands tubercular.

24. *Creamer;* mesenteric glands enlarged, indurated, highly pigmented; supermammary glands enlarged with udder tubercular. Foetal calf (8½ mos.) normal and healthy.

28. HOLSTEIN—*Bull: Marmion*;* bronchial and post-pharyngeal glands enlarged, caseous, calcareous.

29. *Cows—Cigarette*;* lungs contained pus, caseous; bronchial glands not enlarged but caseous, calcareous; mesenteric glands tubercular; supermammary glands greatly enlarged and udder indurated, both tubercular.

30. *Cloverette;* supermammary and mesenteric glands tubercular; some of latter contained caseous matter.

32. *Mercedes Jonkje**;* outer surface lungs mottled with aggregations of tubercles, section showed hyperplasia of interlobular tissue, with little consolidation and no cavities; pleura studded with tubercles; spleen mottled, tubercular; supermammary, superficial inguinal and mesenteric glands all enlarged, tubercular.

33. *Pipchin 2nd*;* lungs filled with tubercular deposits; pleura, pleural side of diaphragm and pericardium studded with tubercles; pleurisy with adhesions; bronchial and post-pharyngeal glands greatly enlarged, calcareous; supermammary and mesenteric glands tubercular; uterus filled with tubercles; ovaries tubercular. Cow had been sterile nearly two years.

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* Physical signs of lung disease.
** Bronchitis and unthriftiness.

Calves Nos. 2 and 5, no indications of tuberculosis. These calves did not react to tuberculin, and were killed as check to test.

The distribution of disease was as follows:

| | |
|---|---|
| Lungs, bronchial and post-pharyngeal glands, | 90 per cent. |
| Udder and supermammary glands, | 73 " |
| Intestinal and mesenteric glands, | 50 " |

*The post-mortems confirmed the tuberculin test without exception. Physical examination alone failed to reveal the presence of the disease in a number of cases.*

The previous history of the cattle is interesting. Six were bought from herds which we now have reason to believe were more or less affected with tuberculosis; three were out of tuberculous Station cows; three were out of non-tuberculous Station cows; one four-year-old healthy cow is out of a tuberculous mother. The cows usually stood in the same stanchions without material change, the Jerseys at the west end, Ayrshires in the middle and Holsteins at the east end. It is interesting to note the location of the diseased cows in the barn. Omitting one cow which had been in the herd but two months, the west seven cows were all diseased; of the next seven, only one was diseased January 1st, although one (Bonnie) developed it later. All of the east five cows were tuberculous. The two ends of the line were diseased, the middle was comparatively free. This would indicate that the primal sources of infection were at the ends of the line. The bulls had been constantly exposed to the disease, since they were fed upon the orts left by the cows. Notwithstanding this, the lesions in the bulls were mainly in the lungs and thoracic glands. It seems probable that the defective ventilation of the barn and the watering device—open buckets in front of the stanchions—aided in the dissemination of the disease. The buckets have been removed and the system of ventilation is being modified.

After the slaughter of the diseased animals, the healthy cows were removed to another barn, and the stable was thoroughly washed with hot water. Following this, every square inch of wood work was sprayed and washed with a solution of corrosive sublimate (1 to 1000) and then 125 pounds of sulphur was burned in the tightly closed stable and cellar. This being done, all the wood work of the mangers and in front of the stanchions was torn out and replaced with new, after which the double sterilization with corrosive sublimate and sulphur was repeated.

About the middle of April, eighteen grade Jersey cattle were purchased at $50 per head from seven herds in Orange County, subject to the tuberculin test. The results of this test are shown in the following table:

| | Normal Temperature at Injection. April 16. 10 P. M. | AFTER INJECTION, APRIL 17. | | | | | | Highest Test Temperature. | Rise of Highest Test Temperature over Normal. |
|---|---|---|---|---|---|---|---|---|---|
| | | 8 A. M. | 9 A. M. | 12 M. | 2 P. M. | 4 P. M. | 6 P. M. | | |
| Julia | 101. | 101.6 | 101.6 | 101.5 | 101.4 | 101.2 | 101. | 101.6 | 0.6 |
| Flora* | 105.5 | 102.6 | 103.8 | 104. | 104.1 | 104.4 | 104.5 | 104.6 | —1. |
| Fanny | 101.4 | 101.6 | 101.5 | 101.8 | 101.6 | 101.6 | 101.8 | 101.8 | 0.4 |
| Jessie | 101.4 | 100.8 | 102. | 101.5 | 101.5 | 101.4 | 101.2 | 102. | 0.6 |
| Fairie | 101.8 | 101.8 | 102. | 102. | 102.2 | 102.2 | 102. | 102.2 | 0.4 |
| Dandelion | 100.5 | 101.6 | 101.6 | 101.4 | 101.4 | 101. | 100.6 | 101.6 | 1.1 |
| Jennie | 100.8 | 101. | 101.2 | 101.2 | 101.2 | 100.8 | 101.6 | 101.6 | 0.8 |
| Belle Black | 101. | 101.4 | 101. | 101. | 101. | 100.6 | 100.8 | 101.4 | 0.4 |
| Violet | 100.6 | 101.8 | 102. | 102. | 101.8 | 101.8 | 100.6 | 102. | 1.4 |
| Bess | 101.4 | 101.6 | 101.6 | 102.2 | 101.4 | 101.4 | 101.6 | 102.2 | 0.8 |
| Dora | 100.8 | 100.8 | 100.6 | 101. | 100.6 | 101.4 | 101.1 | 101.4 | 0.6 |
| Red Top | 100.6 | 102. | 102.4 | 102.2 | 102. | 102.4 | 101.6 | 102.4 | 1.8 |
| Clover | 101.6 | 102.2 | 102. | 101.8 | 101.6 | 101.2 | 103.2 | 102.2 | 0.6 |
| Brownie | 101.6 | 102. | 101.4 | 101.2 | 101.2 | 101. | 101.2 | 102. | 1.4 |
| Maizie | 101.4 | 101.2 | 101. | 101. | 100.6 | 100.6 | 101.2 | 101.2 | —0.2 |
| Golden Rod | 101.2 | 101.2 | 101.2 | 101. | 101. | 101. | 101. | 101.2 | 0.0 |
| Rowena | 101.4 | 101.4 | 101.8 | 101.8 | 101.6 | 100.8 | 101.4 | 101.8 | 0.4 |
| Bettie | 102.3 | 101.6 | 101.2 | 101.2 | 102.5 | 103. | 102. | 103. | 0.7 |

It will be seen that all these animals were found to be free from tuberculosis. It is now intended to test the herd every six months.

It was the aim of the Station to make its former herd of moderate priced animals produce from 350 to 400 pounds of butter per cow by such methods as any dairyman might use. It is our intention to again seek the same end, and, at the same time, keep the herd healthy.

## III. TUBERCULOSIS IN VERMONT.

Since the discovery of tuberculosis in the Experiment Station herd, the Station Veterinarian has had occasion to make in connection with work for the Cattle Commission and in private practice over a thousand injections of tuberculin. The cattle were from 90 herds, of which 83 were in Vermont and 7 were in the vicinity of New York city. Of 941 cattle injected, 222 were declared to be diseased by the tuberculin test, 220 were slaughtered and without exception were found tuberculous. Of 786 Vermont cattle injected, 138 were tuberculous; of 155 New York cattle, 84 were tuberculous. If we omit the Experiment Station herd and one other large herd where five-sixths of the animals were diseased, we find that of 662 cattle but 39 were tuberculous. These were in 81 different herds. These figures do not indicate the prevalence of the disease throughout the State, for, naturally, the injections were made in herds where there was reason to believe the disease existed. It is unsafe to predict the percentage of tuberculosis in Vermont herds from the data at hand, nor can it be determined except by systematic professional inspection. There is enough, however, to warrant the consideration of means for its control. *We wish to distinctly call attention to the fact that no estimate of the percentage of tuberculous cattle in Vermont is made in this bulletin* lest some might construe the ratio of the tuberculous animals found by us in the inspected herds to which we have been called, to be that existing throughout the State.

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*This cow had just calved and the following day was driven nine miles, hence her high temperatures. A later test has shown her to be free from tuberculosis.

The distribution of the disease in the various organs of 139 autopsies was found to be as follows: Lungs, 82 per cent.; bronchial glands, 61 per cent.; post-pharyngeal glands, 18 per cent.; mesenteric glands, 22 per cent.; lymphatic glands in general, 16 per cent,; portal glands, 6 per cent.; liver, 14 per cent.; intestines, 2 per cent.; udder, 22 per cent.; pleura, 7 per cent.; supermammary glands, 23 per cent.; peritoneum, 8 per cent.; spleen, prescapular gland and testicles each, 2 per cent.; uterus and ovaries each, 1 per cent.

Attention is called to the statement and bond of the State Cattle Commission on pages 66-68 of this bulletin.

## IV. GENERAL DISCUSSION OF THE DISEASE.

Tuberculosis is the general name for a class of diseases, of which consumption in the human family is a common type. It is variously named* according to its location in the body and the character of its host. It attacks man, the domestic animals and sometimes wild beasts (particularly if in captivity). Among domesticated animals, cattle, fowl and swine more readily contract the disease than horses, sheep, dogs or cats. The latter easily succumb however, if inoculated either intentionally or accidentally. There is no animal known to be proof against the disease.

*Some of the more common names are: *Human; Lung;* consumption, pulmonary consumption, tuberculous consumption, phthisis, pulmonary phthisis, tubercular phthisis, pulmonary ulceration, quick or galloping consumption (acute miliary tuberculosis) old fashioned consumption (chronic tuberculosis;) *Bowels;* consumption of the bowels, many forms of chronic diarrhoea, cholera infantum and cholera morbus; *Nervous System and Brain;* tubercular meningitis, acute hydrocephalus; *Skin;* anatomical tubercle, lupus and scrofuloderma; *Bone and Joints;* hip-joint disease, white swelling of the knee; *Glands;* tubercular adenitis; *Abdominal cavity;* tubercular peritonitis, tubercular nephritis; *Animal;* same as in human, together with pining, wasting of the lungs, knots, kernels, grapes, angle berries, bovine tuberculosis, pearl disease, pearlsucht, also some forms of nymphomania, satyriasis, etc.

## 1. PREVALENCE AND HISTORY.

*Human.* The ravages of tuberculosis in the human family are far greater than are those of any other disease. The death rate from consumption, which is but one of its many forms, is about one in seven. In all its forms it is said to contribute to the death of one in every four, and the records of human postmortems indicate that one in two has had the disease and either died of it or had its progress arrested.

When conditions have favored its spread, the death rate from tuberculosis has been as high as 50 per cent. of all mortalities. Many of the fatal bowel troubles of infants have their origin in tubercular infection. An article in the Archives de Medicine says that "of the population of the globe, three millions die annually of consumption." It has been well said that, "if the 5490 deaths from tuberculosis which occur every year in the city of New York could be brought together in an epidemic lasting but one week, no small pox, cholera or yellow fever scare would approach the panic which would thus be created,....if we take the whole civilized world and compare with the tuberculosis mortality, all the accumulated deaths from war, famine, plague, cholera, yellow fever and small pox, the latter are comparatively very insignificant." [1]

*Bovine.* The lack of systematic professional inspection of live and slaughtered animals, as well as the actual variations in the extent of the disease in different localities give us somewhat contradictory data regarding the prevalence of bovine tuberculosis.

Probably many of the estimates given by various authors are based on faulty or insufficient data. The following examples may serve to some extent to indicate its prevalence. The extremes are wide, being from 0.02 per cent (among 2,273,547 cattle, mostly steers, killed in the meat inspection districts of the United States from May 15, 1891 to March 1, 1892)[2] to 60 to 70 per cent., (at Hildesheim, Hanover, according to Haarstick). In a large number of German abattoirs it is stated that 6.9 per cent. of the cows, 3.6 per cent. of the steers, 2.6 per cent. of the bulls and 1 per cent. of the young stock were tuberculous[3]. Of 1,270,604 animals slaughtered in German abattoirs from October 1888 to October 1889, 26,352 or 2 per cent. were tuberculous[4]. Careful postmortems by skilled veterinarians showed 12 per cent. of tuberculous animals out of 12,000 slaughtered in England as affected or exposed to contagious pleura pneumonia (a disease entirely distinct from tuberculosis)[5]. In seventeen counties in New York State the inspectors of the State Board of Health found 3.4 per cent. tuberculous cattle out of 20,000 inspected[6]. Cattle slaughtered at Baltimore were found tuberculous to the extent of from 2.5 to 3.5 per cent,[7] while of 1,153 cattle from the Eastern States (mainly New England) slaughtered at Brighton, Massachusetts, 52 or 4.5 per cent. were tuberculous[8]. Salmon and Smith state that "it is not far from the truth to assume....that one of every fifty head of cattle in the more densely populated areas of Europe and America is tuberculous"[9]. Dr. Salmon states yet later, however, that "the ideas in regard to the prevalence of tuberculosis have been radically changed by the facts brought out in using tuberculin[10]."

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[1] Law. Cornell University Experiment Station, Bul. No. 65. p. 105.

[2] Salmon and Smith, Special Report on Diseases of Cattle etc., Bureau of Animal Industry, United States Dept. of Agriculture, 1892, p. 399.

[3] Reported by Law. Ibid. p. 107.

[4] Report of Imperial Health Office, Berlin. Vol. 7.

[5] Annual Report for 1892 of Dr. G. T. Brown, Director of Veterinary Department of the Board of Agriculture of Great Britain.

The fine showing of the Western abattoirs is mainly due to the fact that the beeves killed there are grown out of doors, are slaughtered while still young, and because as a rule only healthy animals are shipped to and accepted by them. On the other hand, Eastern and foreign abattoirs more often deal with stall-fed animals and with old cows, in both of which the proportion of disease is higher.

### HISTORY.

Tuberculosis is no new disease. Both the human and bovine forms have been known for many centuries, under a great many different names. Four hundred years before Christ, Hippocrates[11] described the abscesses and ulcers of the lungs, which characterise the disease to-day. As early as the Middle Ages, the animal type of the disease was considered contagious and the flesh discarded. Various theories regarding its cause have been advocated and shown untenable. Until recently the theory of heredity was considered most probable, but it is now definitely proved that its true cause is bacterial.

## 2. ESSENTIAL OR EXCITING CAUSE.—THE BACILLUS TUBERCULOSIS.

Although infection by inhalation, (breathing), by inoculation (through wounds, etc.), and by feeding was definitely proved by Villemin[12] in 1865, and later by Cohnheim[13], Toussaint[14] and many others, the true cause of the infectiousness of tubèrculous matter was not found until 1882. On March 24th of that year, Dr. Robert Koch of Berlin, Germany, read a paper before the Physiological Society of that city, in which he

[6] County Gentleman, January 18, 1894.

[7] Sixth and Seventh Reports Bureau of Animal Industry, p. 51.

[8] Boston Board of Health. Report by Dr. Alex Burr, Inspector etc., for 1890.

[9] Salmon and Smith, Ibid p. 399.

[10] Breeders' Gazette, Chicago, June 14, 1893.

[11] Littre's edit. of Hippocrates. V. p 675, VI. p 173, VII. p 73.

[12] Etude sur la Tuberculose.

[13] Ubertragbarkeit d. Tuberkulose, Berlin, 1877.

[14] Compt. Rend. XCIII.

announced the discovery of the germ causing the disease[15]. He named this germ *Bacillus Tuberculosis*. The most painstaking care was used in verifying the facts before they were given to the world. Koch demonstrated the presence of the germ in the sputa (spittle) or tubercle (a round nodular mass of diseased matter, small or large, characteristic of tuberculosis), of over a hundred cases of consumption, and successfully inoculated nearly five hundred lower animals, producing in them the same disease. The concluding sentence of his paper has yet to be disproved: "We can with good reason say that the tubercle bacillus is not simply one cause of tuberculosis, but its sole cause, and that without tubercle bacilli you would have no tuberculosis."*

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15. Berliner Klin. Wochenschrift, XV, 1882; also Mittheil aus dem Kaiserlichgesundheitsamte, "Aetiologie der Tuberkulose."

*It may not be out of place to define bacteria and to describe briefly the present status of the germ theory of disease. All matter, soil, air, water, and living beings, vegetable and animal, is prevaded with many forms of minute vegetable life. They belong to several more or less distinct classes or families, but, on account of their microscopic size, they are usually grouped under one name, micro-organisms. Bacteria, fungi, moulds, yeasts, etc., are types of this low order of plant life.

Bacteria (also called microbes and germs) are microscopic plants consisting of single cells or sacs, containing protoplasm, (the vital substance by which the process of nutrition, secretion and growth go forward) reproducing by division and by the production of single spores (a small grain analagous to seed in flowering plants.) Many are capable of motion. They are at present provisionally divided into groups (genera) based mainly upon their form. The principal groups are the globe-shaped bacteria (micrococus), the rod-shaped bacteria (bacillus) and the spiral or cork-screw-shaped bacteria (spirillum). Each of these has many hundreds of species. Each originates only in a germ of its own species, and is never spontaneously generated. Warmth, moisture and organic matter favor bacterial growth. Some species are readily destroyed, others, particularly in the spore form, are very resistant even to extreme degrees of heat or cold. Sunlight, air, (in time) the temperature of boiling water, and certain chemicals are generally destructive to germ life. Fungi, moulds and yeasts differ from bacteria mainly in their methods of reproduction. Many of the common operations of daily life, such as the raising of bread (in part), the souring of milk, the ripening of butter and cheese, the making of vinegar and the nitrifying of organic matter in the soil are due to bacterial action.

Disease also is often the result of the growth of bacteria in the bodily tissues. The pathogenic (disease producing) bacteria are mainly micrococci and bacilli. The causal relation of micro-organisms to disease is proved by the series of tests usually called "the four postulates of Koch:"

1. "The germs must be found in the blood lymph or diseased tissues of man or animal suffering from or dead of the disease.

2. The germs must be isolated from the blood lymph or tissue and cultivated in suitable media outside the animal body. These pure cultures must be carried on through successive generations of the organism.

3. A pure cultivation thus obtained must, when introduced into the body of a healthy animal, produce the disease in question.

4. In the inocculated animal the same germs must be found again."

This chain of evidence has shown that the causes of most contagious diseases are bacterial.

The germ theory of disease is that these minute plants grow in the body, that the products of their growth are poisonous, and that a definite disease is due to the effects of the poisons produced by a definite species of germ.

This germ (bacillus tuberculosis) is a parasitic, vegetable micro-organism, which under the microscope is seen to be a minute rod with rounded ends, usually slightly curved. It is about ten times as long as it is broad, and measures on the average about one ten-thousandth of an inch in length. It occurs singly, in pairs, or in chains of from three to six. It probably does not reproduce itself by spores. This germ lives in the animal body and thrives best at a little above the normal temperature of the human body. It has great vitality, resisting heat, cold, moisture, drought, decay and often the process of digestion. Its virulence is not lessened by drying at temperatures below 150° F. A short exposure at 212° F. or a longer continued heating at from 160 to 170° F. is sufficient to kill the germ. These temperatures are not always attained in the interior of a piece of cooking meat, and a rare steak or roast, if from a tuberculous animal, may contain live germs capable of causing the disease in the person eating the meat. Milk may be used with safety, if heated for an hour at about 160° F. A higher temperature would be desirable, but it coagulates the albumen, gives the milk a boiled taste, lessens the digestibility and increases its tendency to constipate.

The tubercle bacillus has lived for many weeks in ice and been found virulent on thawing. Since moisture and decay do not affect it, wells, drinking troughs and burial grounds (human and animal), in short, wherever tuberculous matter has been exposed or placed, are all liable to be infected. The germ has been found in earth worms which had fed on tuberculous tissue, and it is evident that they may be factors in the spread of disease in bringing buried tuberculous matter to the surface.

## SOURCES OF INFECTION.

*There are three methods of infection :—*

*1. By inhalation (breathing the germs into the lungs).*

*2. By ingestion (swallowing the germs).*

*3. By inoculation (the entrance of the germ by some channel other than the lungs or stomach, as, for instance, through a cut or wound).*

*There are three general sources of infection :—*

*1. The dust of the dried sputa of consumptives or other tuberculous matter; either inhaled or swallowed.*

*2. Contact with the tuberculous material of those suffering from the disease, thus becoming infected either by inhalation, ingestion or inoculation. (For example, in kissing a tuberculous person there might be danger of either ingestion or of inoculation with the tuberculous sputa.)*

*3. The meat and milk of tuberculous animals. (The third source of infection is considered at length on pp. 55–61 of this bulletin.*

The sputa of consumptives containing tubercle bacilli is freely strewn around our streets and buildings. Since the virulence of the germ is not lessened by drying, dust is necessarily a common and omnipresent source of infection. The dust from our streets, stores, dwellings and places of assembly, particularly where tuberculous people live or congregate, is infectious. The dried sputa from the handkerchiefs, the beds and bedrooms of consumptives, and the mangers of tuberculous cattle are particularly rich with the germs. This is the main source of infection to human beings, one to which everyone is exposed. It is not too much to hope that this danger will grow less when more general destruction or disinfection of sputa is observed.

*If this infectious principle is all about us, why does not every one die of tuberculosis?* Many do thus die. As already noted the death rate from but one form of the disease is one in seven, and from all forms, nearly one in four.

Yet on the other hand we have powerful allies in pure air and sunlight. The harmless germs greatly out-number those that produce disease, the war between the various species is one of extermination, and myriads of the disease producing germs are thus destroyed. There are, moreover, natural forces in the body which are antagonistic to germ life. They are the real causes of immunity (the natural organized powers of bodily resistance to the attack of disease) against contagious diseases. There are three main theories explaining this matter. Metschnikoff[16] claims that the tissue-cells of the body, particularly the white blood corpuscles, attack and destroy micro-organisms and that in them the animal body possesses a formidable means of resistance and defense against these infectious agents. Buchner[17] and others consider that the blood serum and tissue juices have germicidal proprieties. On the other hand, Lister[18] claims for the bodily tissues a certain standard of vitality by which they are able to ward off the attack of disease-producing germs. While this standard is maintained the attack is in vain, but when the infection and reduced vitality occur together there is chance for disease. The germicidal action of healthy gastric juice is universally admitted. Immunity against recurring attacks of the same contagious disease is explained in two ways, one by the exhaustion of the peculiar food of the specific germ in the first attack, the other by the existence in the body of sufficient quantities of the self-made germ poison to kill all new comers of the same species.

## 3. ACCESSORY OR PREDISPOSING CAUSES. CONDITIONS FAVORING THE DEVELOPMENT OF TUBERCULOSIS.

There are certain conditions of birth and modes of life which are potent factors in the spread of tuberculosis. The tubercle bacillus alone is its true exciting cause, but there are conditions so favorable to its development that they are well-termed "accessory causes," although strictly speaking they are not causal. The kernel of corn is the essential cause of the growth of the corn plant, and soil, moisture and warmth are accessory causes furnishing conditions favoring its development. The kernel could only grow with great difficulty, if at all, without their help; but on the other hand, there could be no growth whatever, no matter how rich the soil or how favorable the season, unless the seed were planted. Similarly in disease the malady develops only when the germ is present, but the circumstances of individual cases, bodily conditions and surroundings, etc., are of the greatest importance in determining the result.

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[16] Lecture to Institut Pasteur, Dec. 29, 1890.

[17] Eine neue theorie über Erzielung. Immunität gegen Infectionskrankheiten, Munich, 1883.

[18] Quart. Jour. Micr. Soc. London, 1881, n. s. XXI p. 330-342.

Among the conditions favoring the development of tuberculosis, if the tubercle bacillus is present, are:—

*A. Hereditary predisposition.*

*B. Unhealthy surroundings; poor ventilation; uncleanly, dark, damp, hot and cold stabling; soiling system; lack of exercise; climatic influences.*

*C. Faulty feeding; under feeding; over feeding; feeding on unwholesome or indigestible materials; overproduction.*

*D. Faulty breeding; in and inbreeding; early, late and frequent breeding; intensive breeding; lack of constitution.*

*E. Ill health. Temporary predisposition.*

*F. Physical conformation.*

## A. HEREDITARY PREDISPOSITION.

FOR many years consumption was considered a hereditary disease, transmitted from parent to offspring. It was said to run in families. It is now known to be but rarely hereditary, the proved cases of the infection of the fœtus in the womb being less than a dozen. There are on record but six cases of indubitable congenital tuberculosis in calves.[19]

It is not strange that this belief should have prevailed before the discovery of the germ. The well-known prevalence of tuberculosis in certain families is mainly due to two causes; first, to the concentration of the germs in the family home, and, second, to a *lack of resistance, an inherited predisposition to this disease.* A person not thus susceptible may live uninfected in a family whose every member contracts the disease. All breathe the germ laden air, but the unfortunate family are a fruitful soil for its growth, while the stranger is not. Such facts are of common occurrence, and are best explained upon the ground of hereditary predisposition. This inherited tendency is found in cattle as well as in human beings. Dr. Law says: "In 1877 I recognized the existence of tuberculosis in the Jersey herd of Burton Bros., of Troy, N. Y. The worst were slaughtered, but some incipient cases in young animals were turned out in a pasture by themselves, where they passed the summer in apparently robust health, but they began to droop when they returned to the barn in the fall.. I again visited the herd and picked out eleven diseased animals and had them killed, when Dr. James Burton informed me that I had destroyed every representative of a certain family, not even a grade having been left. From that time on there was no more trouble with tuberculosis in that Jersey herd[20].'

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[19] Jour. Comp. Med. and Vet. Arch., Oct., 1893, p. 240.

### B. UNHEALTHY SURROUNDINGS.

*Imperfect ventilation* has much to do with spreading infection. This is because of the repeated breathing of the same air, full of dust and germs, and because of the concentration of the bacteria within a small place. The lack of oxygen lowers the vital powers of animal or man and renders them less able to cope with the germs. An open air life prolongs the life of the consumptive. Tuberculous cattle which are unthrifty in the barn are often apt to pick up on pasture, and to run down again on returning to the barn in the fall (as in the case of the Burton herd cited above.) Of 2,273,547 fat cattle inspected by the officers of the Bureau of Animal Industry at Western abattoirs, only 492 (.02 per cent.) were tuberculous, while out of 54,158 cows from city and country barns 669 (1.23 per cent.) were tuberculous[21]. There were fifty-seven tuberculous animals raised in confinement to one whose life had been spent out of doors. Other data, American and European, might be cited showing the relatively high percentage of tuberculosis in stabled cows.

*Dark, damp and hot or cold stables* are often partly responsible for the spread of tuberculosis. Light is a germicide, darkness a germ-preserver. Light favors the formation of the red corpuscles of the blood. When their numbers decrease, the offices of the blood, including its germicidal action, are impaired and the bodily vigor lessened. The effect is the same as if too little oxygen were inhaled, i. e., equivalent to the effects of poor ventilation. Dampness favors colds, which, as is well known, are often the beginning of consumption. They make the soil more fertile for the growth of the seed. Hot stables make the animal tender and liable to catch cold. Cold stables, or turning cattle out in bitter weather are apt to bring on colds, bronchitis and pneumonia, which prepare the way for tuberculosis of the lungs.

*Soiling cattle*, their confinement with little or no exercise the year round makes unending the conditions already cited which otherwise last but half the year. Local circumstances sometimes compel this method of dairying, but cattle thus kept should be watched with great care for indications of disease.

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[20] Law, Tuberculosis in Animals. Report New Hampshire State Board of Agriculture, 1892. page 16. Also reported in Cornell Univ. Expt. Stat. Bul. 65, p. 112.

[21] Salmon and Smith, Ibid, p. 399.

*Climate* has its influence in spreading tuberculosis. A moist, changeable climate favors its development, while dry and rare air and uniform temperature tend to suppress it. The high table lands of the far western states afford relief to the human consumptive and possibly to the animal. Bovine tuberculosis is said to be unknown in those regions, and there are those who believe that in its earlier stages its course may be arrested by removal to high altitudes.

### C. FAULTY FEEDING.

It is self-evident that underfeeding and the use of unwholesome or indigestible food lowers the vitality and hence the resistant powers of the animal. Overfeeding, either as gluttony or in the use of too rich a ration, or irregular feeding, are apt to cause indigestion and dyspepsia, thus predisposing to the disease. Heavy, stimulating feeds lead to over-production. The high production of milk and butter places the animal under a severe strain and tends to weaken her constitutional vigor and increases susceptibility.

### D. FAULTY BREEDING.

*In and in-breeding** intensifies both good and bad traits. It concentrates desirable lines of personal and family character, but, unless carefully and intelligently managed, is liable to weaken constitution and conduce to disease. Line breeding, the most desirable type of in and inbreeding, is that by which our improved breeds of domestic animals were originated and perfected, and, when due regard is given to ancestral health and vigor, is often advantageous. Incestuous breeding, however, is to be condemned for it increases susceptibility, and often produces unsatisfactory results. Cattle thus inbred are proverbially liable to tuberculosis.

*Early, late and frequent breeding* are all liable to sap the bodily strength. The nourishment which should restore the maternal vigor is diverted to the development of the unborn offspring and to the making of milk. If bred too young, the mother's growth is stunted, and the offspring is apt to be weak and puny; if bred too late or too often, the constitution suffers from the strain. All such are probably more susceptible to infection than if bred with more care.

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*In and in-breeding is usually considered to mean the pairing of close relations. Breeders differ as to degree of relationship covered by the term. It may mean only the coupling of animals of the precise same blood (brother and sister) or the frequent pairing of relations. Miles calls attention to the confusion of definitions, and says: "If the terms in-breeding, close breeding and interbreeding are used to indicate the breeding together of closely related animals in a single instance, or at long repeated intervals, the term in and inbreeding could then be used with greater exactness to indicate the frequent repetition of the process." (Stock Breeding p. 138). For the present purpose the distinction may be drawn between incestuous breeding (brother and sister, parent and offspring, etc.) and line breeding (within the limit of a family and for a particular type of animal, generally without regard to relationship, not of necessity incestuously bred, but closely bred.)

*Intensive breeding*, the mateing of animals of great milking strains with the hope of yet greater performance in the offspring, is attended with the dangers already cited due to the artificial nature of the animal, and needs to be done with intelligence. Breeding from animals themselves tuberculous is, of course, to be condemned. This itself is not apt to produce the disease, but the offspring have decided predisposition.

*Tuberculosis is not confined to any breed, nor is any breed exempt from it.*

The modern dairy cow is a highly artificial animal. She has been compared to a machine for the conversion of raw material, fodder, into the finished product, milk. The intelligent engineer works his machine to the full extent of safe production. The dairy cow should be similarly handled, and an undiminished strength of constitution made the measure of her production. The better types of the modern dairy cow are striking examples of ability, energy and intelligence in lines of breeding and feeding. These are by no means to be abandoned. *We argue for a due regard for the danger which attends high production, for healthy surroundings and vigorous ancestry, and for a watchful, intelligent care to weed out and keep out disease.* The valuable qualities of our best dairy cows may thus be preserved and transmitted, uncontaminated, to future generations.

### E. ILL-HEALTH.

*Sickness* of any kind, acute or chronic, favors infection. This is particularly true of such as irritates the organs of respiration (colds, bronchitis, pneumonia, etc.) or interferes with digestion (dyspepsia, indigestion, diarrhœa, etc.) An enfeebled system less vigorously resists attack. An irritated respiratory tract is fertile surface for the growth of the tubercle germ. The healthy gastric juice, being acid, kills most germs, but an unhealthy stomach with weakened or diminished secretions offers less resistance to the passage of bacteria to the alkaline bowel where all the conditions are favorable to their growth and multiplication.

*Temporary predispositions* to tuberculosis occur in all individuals, human or animal. A hard cold, an overworked condition, or a fit of indigestion renders one temporarily much more open to infection than usual. Our bodies are continually at warfare with the germs. In health we conquer, but if the vitality be lowered we become for the time being susceptible. Since we cannot predict when infection and lowered vitality will coincide in ourselves or our animals, it is desirable to avoid both so far as possible.

### F. PHYSICAL CONFORMATION.

Cattle with narrow chests, light barrels and long legs are, because of their build, apt to be predisposed to tuberculosis. Their circulation is generally poor, and they are apt to be poor feeders and unthrifty.

## 4. SYMPTOMS OF BOVINE TUBERCULOSIS.

Tuberculosis in cattle sometimes assumes the acute form, but is usually of the chronic type, lasting for years. Mankind attacked by either form generally shows it by failing health. Cattle, on the contrary, seldom give external evidence that they have the disease until it is far advanced. The effects of the disease are too slight at first to materially interfere with the functions of the organs involved. The animals may and do live for years with decided tubercular lesions, and yet appear healthy, fattening readily and yielding large amounts of apparently normal milk. In the acute form, however, and in the last stage of the chronic, fever and wasting of the body occurs. The marked difference in outward evidences of human and bovine tuberculosis lead many to doubt its existence in apparently healthy animals. The public slaughter of tuberculous cattle is always accompanied by a storm of protests from bystanders, which are generally quieted by the post-mortem results.

Although difficult to detect in its early stages, except by the use of tuberculin, the symptoms of tuberculosis are quite marked when the disease is well advanced. The following concise description of advanced bovine tuberculosis is taken from the Special Report of the Bureau of Animal Industry on "Diseases of Cattle and Cattle Feeding," page 405. Lydtin quotes the following description of the disease as taken from a Swiss sanitary order:

> "A dry, short, interrupted, hoarse cough, which the sick animals manifest especially in the morning at feeding time, still more after somewhat violent exertion. At first these animals may be full-blooded and lay on a considerable amount of fat when well fed. As the disease progresses they grow thin and show more and more those appearances which indicate diseased nutrition, such as staring, lustreless, disheveled coat; dirty, tense skin, which appears very pale in those regions free from hair. The temperature of the skin is below normal. The loss of fat causes sinking of the eyes in their sockets. They appear swimming in water and their expression is weak. The cough is more frequent, but never or very rarely accompanied with discharge. The body continues to emaciate even with plenty of food and a good appetite, so that the quantity of milk is small. At times in the early stages of the disease, still more in the later stages, the diseased animals manifest considerable tenderness when pressure is applied to the front or sides of the chest, by coughing, moaning, etc. Often all symptoms are wanting in spite of the existence of the disease."*

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*After mature consideration and consultation with the Board of Control of the Station and the State Board of Agriculture (acting as Cattle Commission) it was deemed inadvisable to attempt to describe the symptoms of bovine tuberculosis more fully than above, on the ground that they were so obscure and variable except in advanced cases that any description would be apt to be more misleading than instructive.

## 5. LESIONS OF BOVINE TUBERCULOSIS.

It is not a simple matter for the non-professional to detect bovine tuberculosis, and in many cases the trained veterinarian cannot determine its presence by physical examination. More definite knowledge may be obtained by the following means:

1. Examination of the sputa and milk with the microscope for the tubercle bacillus.
2. Inoculation of smaller susceptible animals (rabbits, guinea-pigs, etc.) with the suspected material.
3. Slaughter and post-mortem.
4. The injection of tuberculin.

Dismissing the first two means as not within the scope of this bulletin, the third may be used either alone or as confirmation of the fourth. In either case it is desirable to be able to recognize the lesions (changes produced in the texture of the organs by the action of disease) of tuberculosis.

The organs usually affected are:—

1. Breathing: The lungs, throat and their glands.
2. Digestion: The stomach, intestines, mesenteric glands.
3. Abdominal glands and urinary organs: The liver, spleen, pancreas, kidneys and bladder.
4. Reproduction: The womb, ovaries and fallopian tubes.
5. Lactation: The udder and its lymphatic glands.
6. The lymphatic glands in general.
7. Serous membranes; pleura, peritoneum, pericardium.
8. The skeleton; bones, joints.

Sometimes but one organ is affected, sometimes several, the symptoms varying with the location of the disease. In the former case the disease is called localized, in the latter, generalized tuberculosis.

The lungs and bronchial glands are most commonly affected, then the intestinal canal. The distribution of the disease in the various organs is well shown in the following tables of post-mortem examinations copied in a condensed form from the "Report on Tuberculosis in Ontario, presented to and adopted by the Provincial Board of Health, by P. A. Bryce, M. A., M. D. Secretary." The results obtained in cattle by one of us is added at the foot of the table.

| Class of *post mortem.* | By whom. | Number in each. | Lungs. | Bronchial and Mediastinal Glands. | Pleura. | Mesentery and Intestines. | | Liver and Uterus. | | Spleen and Udder. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Mesentery. | Intestines. | Liver. | Uterus. | Spleen. | Udder. |
| | | | % | % | % | % | % | % | % | % | % |
| Ontario Agricultural College herd | Mackenzie | 28 | 64 | 85 | .. | 7 | 7 | 42 | .. | .. | 7 |
| Ottawa Experiment Farm herd | Robertson | 30 | 83 | 73 | 26 | 13 | 4 | 43 | 6 | .. | .. |
| New Jersey (cattle) | Conrow | 48 | 70 | 56 | .. | .... | .. | .. | .. | 2 | 25 |
| Germany (cattle) | Roeckl | 7329 | 75 | 29 | 55 | 48 | 1 | 28 | 10 | 19 | .. |
| Vermont | Rich | 138 | 82 | 61 | 7 | 22 | 2 | 14 | 1 | 2 | 22 |

In 7, 329 cases of more exact returns of *post mortems* in cattle, the results are given as follows :

| | | Per cent. |
|---|---|---|
| General tuberculosis | 459 | 6.26 |
| Lungs | 5,178 | 75.87 |
| Pleura pulmonalis | 3,812 | 55.49 |
| Peritoneum and mesentery | 3,316 | 48.27 |
| Pleura of chest-wall | 3,209 | 46.71 |
| Bronchial glands and mediastinal glands | 2,022 | 29.48 |
| Liver | 1,940 | 28.24 |
| Spleen | 1,273 | 18.58 |
| Uterus | 699 | 10.17 |
| Inguinal glands | 364 | 5.30 |
| Pharyngeal glands | 299 | 4.35 |
| Trachea | 233 | 3.39 |
| Udder | 111 | 1.62 |
| Intestinal | 89 | 1.30 |
| Ovary | 86 | 1.25 |
| Lymph glands of liver | 80 | 1.16 |

The lymphatic glands of the thorax and abdomen, the heart, kidneys, stomach, brain, bones, etc., were found diseased in less than one per cent. of the cases.

Wherever the germs locate in the body, they multiply, thus irritating the tissue, forming a round nodular mass, the so-called tubercle, which gives the disease its name. The newly formed tubercle is always small, usually about the size of a millet seed,* is soft and red, or sometimes firm, white and fibrous. In chronic cases, aggregations of small tubercles become soft and cheesy with a limy material in the centre, disintegrate and run together, forming yellowish, cheesy masses of various sizes imbeded in the tissue of the organs involved. These masses of degenerated or broken down tissue contain caseous (cheesy) matter, calcareous (limy, gritty) matter and pus, sometimes one, and often two or all of these. This degeneration is caused by the actual death of the tissue. Unless the lesion is recent the mass is sometimes enclosed in several concentric layers of connective tissue like the skin of an onion, an effort on the part of nature to bury the diseased portion and render it harmless.

The surface of the lungs, pleura, (lining of the chest cavity over the ribs and diaphragm) and peritoneum (lining of the abdominal cavity) are frequently studded with tubercles, being sometimes so thick as to resemble a cobblestone pavement, or, with clusters of tubercles which look like miniature bunches of grapes. This form of the disease is commonly called pearl disease, pearlsucht, grapes, angleberries, etc. Several of the Station herd were thus affected. The lymphatic glands are usually enlarged, caseated and calcareous. They are often almost impossible to cut open, because of the deposit of gritty material. The bronchial lymphatic glands which normally are about as large as horse-chestnuts are particularly liable to enlargement and degeneration. The bowels may be ulcerated and have tubercles on them. In short, any organ affected will have tubercles in it varying from the microscopically small miliary tubercle through the pea-sized, soft red or firm white nodule, to larger masses of degenerated tissue, caseated, calcareous or broken down into pus. (See plates showing lesions, pages 48-49.) Sometimes the tubercles are all so small that it requires microscope to detect their presence. The cow Creamer, belonging to the Station herd, was thus affected in the udder, there being almost no evidence of the disease elsewhere. She would have passed any abattoir inspection as sound and healthy, yet her udder was full of microscopic tubercles and her milk unquestionably infected.

These lesions are characteristic of the disease and their extent measures its progress. Glanders (which does not affect cattle), actinomycosis (lump-jaw) and pleurisy with adhesions are the only diseases which are liable to be confounded with tuberculosis. Usually the restricted localization of the lesions of the two former will serve to distinguish between them. In lump-jaw the lung often contains cheesy masses, rather more yellow than are those due to tuberculosis and containing small grains. In pleurisy with adhesions, in which the lungs have to be torn away from the ribs, the absence of tubercles will aid in determining the character of the disease. Both glanders and actinomycosis are contageous to both man and beast. No mistake would be made in slaughtering the animal whichever disease was at fault.

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*The comparison in size to a millet seed has given a name, acute miliary tuberculosis, to that orm of the disease in which the tubercles are all small and form rapidly.

The one entirely satisfactory evidence of tuberculosis is the detection of the germ and reproduction of the disease. If a germ is found in a nodule of any character which is a rod about one ten-thousandth of an inch long, which both stains and bleaches with difficulty, it is probably tuberculosis. If the tissues injected into a susceptible animal produce tuberculosis, the diagnosis is established beyond question.

## 6. THE TUBERCULIN TEST.

In August and November, 1890, Dr. Robert Koch[22], the first to identify the tubercle bacillus, published the results of experimental work upon tuberculous guinea pigs with a fluid of his own preparation. This fluid (Koch's lymph or tuberculin) was stated at a later date to be the concentrated, sterilized and filtered liquids in which pure cultures‡ of the bacillus tuberculosis had been grown[23].

It has been know for many years that animal decomposition and putrefaction are the results of bacterial growth. The growth of many of these germs gives rise to the formation of peculiar alkaloids,* most of which are very poisonous. These bodies as a class are called corpse alkaloids or ptomaines, from *πτομα* a dead body. The many cases of poisoning from eating cheese, ice cream, fish and putrid meat are usually due to the formation of ptomaines in these materials. It is now believed that each disease producing germ develops, as a function of its life, ptomaines peculiar to itself†. Many of these have been isolated and their properties determined. Tuberculin being a glycerine extract of pure cultures of the tubercle bacillus contains the ptomaines peculiar to that germ, the chemical poisons which the life functions of the germ have created. These are the immediate though not the ultimate causes of tubercular lesions.

Tuberculin is prepared by growing the tubercle bacillus in a pure culture until highly concentrated and until a large amount of its ptomaines is developed. Glycerine and carbolic acid are then added and the mix-

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22-23. Deutsche Med. Wochenschrift, 1890.

‡ A pure culture consists of the growth of one species of germ by itself, all others being excluded.

* Organic chemical compounds, existing in many vegetables and animals, containing nitrogen, carbon, hydrogen and oxygen. They generally include the active principle of the plants Examples: Theine in tea, morphine in opium, quinine in Peruvian bark, strychnine in nux vomica, tyrotoxicon in poisonous cheese, ice cream, etc.

† See last paragraph of the footnote on page for "germ theory of disease."

ture is filtered through a porcelain plate to remove the germs. The filtered fluid is heated to a high temperature to destroy the vitality of any germs which may have passed the filter and then evaporated at a low temperature in a vacuum until concentrated. The German or Koch tuberculin is put up in five gram bottles and retails in New York for about $10 a bottle ($1,000 a pint). It is diluted one to ten, before use. The tuberculin made by the Bureau of Animal Industry is put up in in 12 c. c. bottles and is used without dilution

The test with cattle is made by injecting the fluid under the skin of the neck or shoulders by means of a sterilized hypodermic syringe. The syringe and the skin and hair at the point of injection are first carefully disinfected in order that no disease-producing germ may enter the system. The German tuberculin is diluted with nine times its volume of a one per cent. solution of carbolic acid, and from one to four cubic centimeters (a cubic centimeter is about one-thirtieth of a fluid ounce) of the diluted lymph is used. The cost of the tuberculin used in an average sized injection is about fifty cents.

The normal temperatures are usually taken before and at injection. Tuberculous animals respond by a rise in temperature, usually beginning from six to ten hours after injection, but exceptionally not showing until as late as sixteen to eighteen hours. There is usually no marked swelling at the point of injection, but sometimes uneasiness, rigors, chills and diarrhœa are noticeable. Diarrhœa often affects healthy cattle also, and is caused by the expulsion of the tuberculin by way of the bowels. In some of our work at this Station and in the State the "normals" * have been taken some days after injection. This has worked well and saved taking the "normals" of animals which later prove to be healthy. It is not safe, however, to take these temperatures the day after injection, as the temperature often rises the second day nearly as high as on the day after injection. All temperatures are taken by inserting a clinical thermometer into the rectum or vagina for from three to five minutes. Normal temperatures should be taken at least twice. The temperatures after injection should be taken at least once in three hours, beginning six hours after and continuing until twenty to twenty-four hours after injection. Variations occur in the normal temperatures of different cows and of the same cows at different times in the day. The average normal temperature of a cow is not far from 101.8°F. It may rise to 102.5° or sink to 100°. *An increase of 2° over normal temperature after injection is ground for suspicion*, unless there is evident reason for it (cow in heat or near calving, change of conditions or surroundings, etc.) while higher figures make the case yet more clear.

*There is need of careful observation and trained intelligence in the interpretation of the results of the tuberculin test*, since apparent reactions sometimes occur which might mislead the unskillful or careless. *The test is too delicate for ordinary hands.* The Bureau of Animal Industry and the importers of the German goods are exceedingly conservative in placing the lymph only with responsible parties.

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* The temperatures taken before injection.

The action of tuberculin upon the tubercle bacillus is that of an excitant. It arouses the germs to increased activity, hastens the progress of the disease, tends to scatter the infection throughout the body and throws the animal into a feverish condition, as shown by a rise of bodily temperature of from 2° to 8° F. The tubercular tissue degenerates rapidly through the usual stages, the germs rapidly increase in number, a new extension of the disease in the form of acute miliary tuberculosis usually occurs and death by so-called "quick consumption" ensues. This action is what brought Koch's lymph into disfavor as a cure, except in cases of lupus (tuberculosis of the skin) and other localized forms of the disease where the diseased tissue is sloughed off. But the very features which prohibit its use as a cure are those which give it its value as as a diagnostic agent (means of determining a disease by distinctive marks, symptoms or characteristics) in cattle. The tuberculous animal because of the very presence and action of the tubercle bacilli in its system becomes more or less charged with tuberculin. The system is inured to this, however, but it is supposed that its balance is upset by the injection of more tuberculin, the germs are excited to greater activity and fever ensues.

Tuberculin was first used as a diagnostic agent in veterinary practice in 1891 by Prof. W. Gutmann[24], of the Veterinary Institute, Dorpat, Russia. The Tuberculosis Commission of the Veterinary Department of the University of Pennsylvania, Prof. W. L. Zuill[25], Chairman, were the first to use it in this country, late in the same year. Many of the Experiment Stations, Cattle Commissions and veterinary surgeons of this and other countries have experimented with it since this time and have generally found it successful.

The Experiment Stations of Canada, Vermont, New York, New Jersey, Pennsylvania, Virginia, Wisconsin and Minnesota have used it with convincing results. A list of their publications on the subject will be found at the end of this bulletin.

Quotations might be made from the reports of many investigators, American and foreign, but the following may suffice:

"We shall now stop publishing reports on tuberculin in the Berlin Veterinary Weekly unless they contain some new facts or views. Since the publication of the reports of the extensive experiments of the Royal Health office, we may regard the question of the value of tuberculin in the diagnosis of tuberculosis of cattle as settled. The proof which has been presented to our readers is more than sufficient. The results are absolute and gratifying, and show that tuberculin is a reliable agent for determining the presence of tuberculosis in cattle[26]."

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[24] Balt. Woch. f. Landw. Geweberfl. u. Handel; also reported in Deutsche Molkerei Zeit., 1891, pp. 81-83.

[25] Jour. Comp Med. and Vet. Arch. Nov., 1891.

### OBJECTIONS TO THE TUBERCULIN TEST.

Objections having some basis in fact have been raised to the use of tuberculin in veterinary practice. They are, briefly stated:

1. The temperature of healthy animals and those affected with other diseases sometimes rises after the injection of tuberculin.
2. Some tuberculous animals do not react to tuberculin.
3. Tuberculin does not determine the stage of the disease, but condemns animals which might live for years and possibly recover.
4. Tuberculin may produce the disease in healthy animals, and certainly hastens its progress in those affected.
5. Any test to be effective must be followed by thorough eradication. It is impossible to stamp out tuberculosis for financial reasons and because of its prevalence in the human family.

To the first, second, third, last half of the fourth and the fifth counts in the inditement the test must plead guilty. *The tuberculin test is not infallible.* There have been mistakes made in its use by incompetent persons and it has occasionally failed in careful hands. Experience, however, has brought a greater measure of success, unfavorable reports are now rare and many who considered tuberculin unreliable are acknowledging that the fault was their own. But, notwithstanding its occasional and admitted failures, it has proved infinitely more reliable than any other means of diagnosis now in use.

Let us consider these objections:

*1. Apparent reaction of non-tuberculous animals.*—Every animal is liable to fever and may be thus affected after a tuberculin injection independant of tubercular lesions. A cow for a few days before, at, and for some days after calving may have abnormally high temperature. Yet, on the other hand, one of us has had healthy cows calve in the middle of the test without showing any fever whatever. We have also found that the standing, due to the necessity of frequent taking of temperature, tends to cause acute laminitis (inflammation of the sensitive structure of the feet) accompanied by a rise of temperature, which might be mistaken for a reaction caused by tuberculin. The altered conditions of confinement during summer when the cows are naturally at pasture may also cause a fevered condition. Cows in heat are apt to be feverish. The temperatures of such cows fluctuate more than those of a cow reacting to tuberculin. Such cases are usually readily detected by the careful observer. Great care should be used in the inter-

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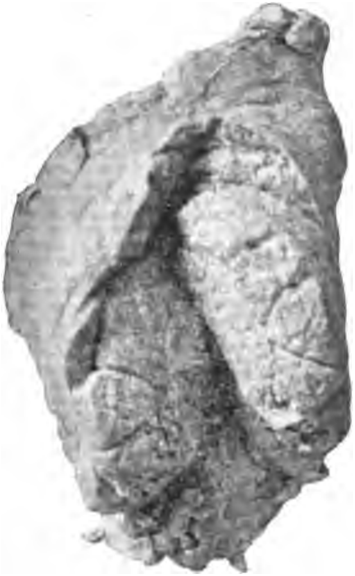
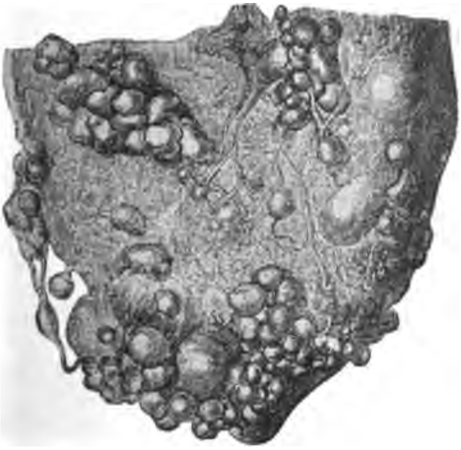
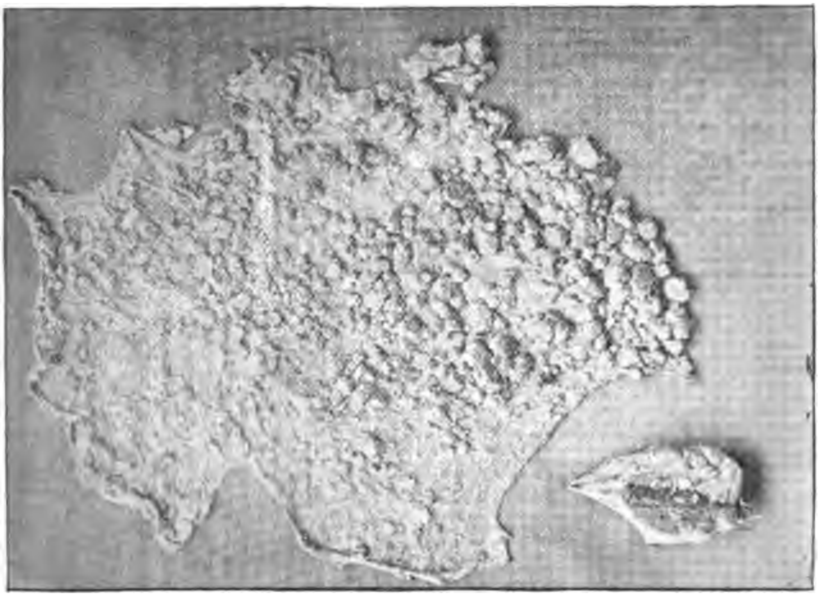
[26] Berliner Thier. Wochenschrift, June 16, 1892.



Section of a lung tubercle from Experiment Station cow "Sadie's Delight." The tubercle is the bean-shaped mass standing out from the cut. It contained caseous and calcareous matter.



A portion of a tuberculous lung (bovine). [After Virchow.]



An aggravated case of tuberculosis of the omentum (covering of the abdominal viscera); also a tuberculous gland. (Reproduced from photograph loaned by Dr. Drinkwater, Rochester, N. Y.)

Opened glands from Experiment Station cow "Floss." The caseous degeneration is shown by the roughened surfaces. These glands are several times normal size.

pretation of the results of the injection of two-year-olds with their first calf. The explanation for this may be that the changes caused by their first gestation are such as to render their systems readily fevered by any excitement. Care should be taken not to inject directly into a lymph or blood vessel, lest neighboring glands become inflamed. Mistakes have been made by careless post-mortems, and many who have reported reactions in healthy animals are acknowledging that they failed to make careful examinations of all organs, bones, joints etc., or did not use the microscope. It has been claimed that animals suffering from actinomycosis may react to tuberculin. From a practical standpoint, since lump jaw is contagious, and communicated to man, this makes little difference, yet it is not impossible that there may have been tubercular lesions overlooked in these cases. One of us had two cases of this kind. One cow with lump-jaw gave no reaction whatever to tuberculin; another with both tuberculosis and lump-jaw gave the highest reaction (108.6°) yet obtained.

2. *Non-reaction in tuberculous animals.*—These cases are sometimes found. We have found two cases of non-reacting tuberculous cattle in over a thousand injected. This may be explained in two ways. It is a well-known fact that some individuals are not affected in the ordinary manner by certain drugs. For instance, morphine does not narcotize some people. It is possible that these cases may be similarly explained. Or, the animal may be so thoroughly diseased that its system is already saturated with the natural tuberculin, so that the slight addition has no effect. Usually such cases may be detected without recourse to tuberculin or in spite of its lack of reaction. We have noticed in our experience that very old cows do not respond so readily to the usual amount injected.

3. *Indiscriminate Condemnation of all Stages of the Disease.*—Neither the length of time elapsing between injection and reaction, the duration, or the heighth of the fever indicate the extent of the lesions of the disease. The slightest and most recent cases, as well as those of long standing are betrayed. Herein lies the peculiar value of the test. It is questioned by some veterinarians whether for practical purposes animals very slightly affected should be considered tuberculous. Probably many might live for years without marked advance of the disease. But who shall say in such cases when the danger line is passed? Is it worth while to prolong for a year or two the life of a few confessedly tuberculous animals to run the risk of infecting a herd as well as human beings? While many animals but slightly affected might live for years in apparent health and usefulness, a tuberculous animal, whatever its condition, is a constant menace to the other members of the herd, and to those who care for it or consume its products. If to-day the germs are inactive, to-morrow they may pass into the blood, to the udder and infect the milk. It is stated on good authority that the tubercle germs may exist in the milk even when the udder is not affected. The preservation of a single tuber-

culous animal invites renewed disease. There are as yet few, if any, authenticated published accounts of cured bovine tuberculosis, although possibly favorable climatic conditions may arrest the progress of the disease. Viewed solely from a monetary stand-point the truer economy lies in the exclusion of every possible source of future infection.

4. *Production of the Disease in Healthy Animals and its Aggravation in Tuberculous Animals.*—Tuberculosis is primarily due to the tubercle bacillus. If the lymph is properly made and sterilized every germ and spore in it is killed, and hence it cannot cause the disease.

During the preparation of this bulletin one of us wrote to a large number of veterinarians all over the United States, asking among other questions whether it was possible for tuberculin to cause tuberculosis, or any other disease, in a hitherto healthy cow. But two replies were received in the affirmative while a large number claimed the impossibility of such infection with properly made and carefully handled tuberculin. These two replies were received from gentlemen, eminent in the profession, who have been working together. They base their belief in the possible infection of healthy animals upon the fact that they have found the bacillus in tuberculin, and they claim that it is unwise to use the material until more is known of its power to produce immunity, or possibly a predisposition to tuberculosis.

The first claim simply emphasizes the necessity of care in the preparation and use of the material. The lymph was first used for diagnostic purposes in veterinary practice nearly three years ago, and the evidence is already strong against the probability of any predisposition being caused. For example, the Pennsylvania Experiment Station herd was first injected in June, 1892 and has been twice injected since, the last time within a few weeks. The disease was discovered on the first injection, but not on either of the succeeding trials[27]. It is nearly two years since we first used tuberculin and cattle then injected and recently retested have shown no evidence of disease. While this evidence is only negative, it is confirmed by similar tests elsewhere. There is still much to be learned in the use of tuberculin. It is already claimed that other materials will cause the same febrile reaction. Taurin and Kreatin (Merck's) have given good results in the hands of Dr. W. L. Zuill of Philadelphia, and E. Centauni claims that "it has been proved that identically the same action as that of tuberculin can be produced by the injection of the extracts or other products of various bacteria, even such as are known to have no pathogenic (disease-producing) proprieties[28]." If further experiment confirms these results, and these or other materials are found to be as reliable as tuberculin, they should and undoubtedly will supplant it, since they obviate the danger which lies in careless making and use of tuberculin.

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[27] Penn. State Coll. Agl. Expt. Stat. Bul. No. 21, Oct. 1892.

[28] Berliner Klinische Wochenschrift, Nos. 7 and 8, 1894.

The aggravation of the disease in tuberculous animals is not a valid argument in cases where such as react are promptly killed. No one who expects to keep his mild cases should permit its use, for it only makes a bad matter worse.

5. *A thorough eradication an impossibility.*—The complete eradication of tuberculosis, its "stamping out" is not a work of years, but of decades, perhaps centuries. But increased knowledge and better means of detection enable us to make a stronger fight against it. We now know how and why it attacks, may detect its presence and do much to prevent its ravages. We may confidently expect yet more light as time goes on. If we cannot eradicate tuberculosis in the near future, let us do what we can in that direction.

When the great conflagations of Chicago and Boston were at their height, the firemen did not reel up their hose and go home because the flames were apparently beyond their control. They worked around the edges of the fire, and blew up buildings yet unburned in its path. They did what they could, and finally controlled the flames. Similarly, in the battle with human and animal tuberculosis, weeding out disease here and there, disinfecting, and the destruction of property in the shape of animals in the interests of the public health are good policy until better knowledge and means enable us to do more complete work. The question of the relation of the State to the individual and to disease will be considered later in the bulletin, (pages 63-68.)

## 7. INTER-RELATION OF HUMAN AND BOVINE TUBERCULOSIS.

*Bovine tuberculosis is infectious.* Hundreds of experiments have proved that this disease may pass from a tuberculous to a healthy animal. Stahl cites 650 experiments in the transmission of tuberculosis to lower animals by direct experiment with convincing results in every case. Koch[29] and others have inoculated healthy animals of many sorts with tuberculous bovine tissue and reproduced the disease. Bollinger[30], Ernst and Peters[31] and others have infected calves and swine by feeding them tuberculous milk. The unboiled milk of tuberculous cows, without indications of diseased udders, infected a herd of English pigs[32]. The mother of calf No. 8 of the Station herd is healthy, and the tubercular mesenteric lymphatic glands of the calf were probably due to drinking the herd skimmilk. A litter of five pigs out of apparently strong and healthy parents, were killed last winter by one of us. All were tuberculous, and in one case it was generalized and far advanced. They had been fed on the mixed skimmilk of a creamery, and on two different occasions cows supplying this creamery had been tested and killed because of tuberculosis. Many of the pigs fed on the skimmilk of the Mountain View herd at East Burke, Vt., (78 out of 91 cattle found tuberculous by the tuberculin test and confirmed by postmortem) were found when butchered to be as tuberculous as the cattle. At another farm where the Station veterinarian was called to use the tuberculin test, over sixty cows, over a hundred hogs, all the chickens, the dogs and even the family cat were exterminated because of this disease. The location of the disease at both ends of the line of cows in the Station barn, with but one diseased cow in the middle is suggestive in this connection.

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[32] British Medical Journal, I, 1889, 30.

[29] Loc. cit.

[30] Munchener Med. Wochenschr. 1889.

[31] Publications Mass. Soc. Promot, Agr.

*Human tuberculosis is infectious.*—This belief was held before the Christian era. About a hundred years ago the doctrine of hereditary transmission was advanced, but our present knowledge of its germ origin has forced the profession back to the old belief in infection with hereditary predisposition as an accessory cause. There are now scores of observations on record in medical journals which are positive evidence. Without going into details a few may be cited:

Italy's mild climate has long invited consumptives from every direction, who have so infected the country that even among its natives the disease is almost epidemic and its consumption death rate higher than that of any other European country.

"Prison consumption is notorious. Kennan[33] reports it to be a great scourge in Siberian prisons. There is usually a greater proportion of this disease in "institutions" than where human life is less seggregated. Cornet[34] found during twenty-five years in thirty-eight cloisters, 2,099 nuns acting as nurses had died. Of these, 1,300 or sixty-three per cent. had died of tuberculosis, or four and a half times the usual percentage. This seemed due almost entirely to their greater exposure to infection."

A recent example close at hand may be found in the report for 1893 of Dr. J. B. Ransom,[35] physician of the State's Prison at Dannemora, Clinton County, New York. He states that the percentage of total deaths from tubercular disease in that prison is over 80 per cent. In a private letter to one of us he states that he does not connect this with the milk supply, which is but small per man.

"In a lying-in hospital in Berlin was a nurse whose business it was to resuscitate children who were born asphyxiated by breathing into their lungs. Of ten infants so treated every one died of tuberculosis. This nurse died and upon examination showed that her lungs were tuberculous. The children were shown to have been born of healthy parents.[36]"

Three Grecian surgeons injected the sputa of a consumptive into the thigh of a fisherman whose death from gangrene was inevitable. Previous to injection they examined and found the lungs sound and healthy. He had no known hereditary predisposition to tuberculosis. In three weeks the lungs showed signs of disease, and at death (from gangrene) in thirty-eight days after injection, seventeen tubercles were found at the summit of the right lung, two on the upper part of the left lung and two on the liver.[37]

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[33] Century Magazine, June, 1889, p 172.

[34] Zeit. fur Hygiene, VI. 1,64.

[35] Annual Report of Supt. Prisons of the State of New York for 1893, p 181; also Report Proc. National Prison Assoc. 1894.

[36] Berliner Klinische Wochenschrift, No. 37, 1878.

Eight cases of consumption occurring within a few months in an English convent were traced to a single case. There had been no isolation, but all had slept in the same general dormitory. On isolation of the sick and proper disinfection the disease stopped.[38]

Biggs[39] cites a case reported by Schwenninger. Tappeiner conducted experiments on dogs causing them to breath air artificially infected with tubercle baccilli. His servant not believing in the danger and disregarding warnings, persisted in entering the inhalation chamber. He was free from hereditary predisposition, robust and healthy. He died of acute tuberculosis in fourteen weeks, and an autopsy showed the same lesions as those found in the dogs.

Dr. Dewevre of Paris noted that three brothers, all his patients, successively sickened and died of tuberculosis. They had shared the same bed, and were all bed-bug bitten. He found this bed over-run with bed-bugs, and learned that it had been thus infested for five years. Thirty bugs were caught and put upon three healthy guinea pigs, all of which soon died, and post-mortems showed well-marked tuberculosis. From the diluted and filtered pulp of fifty crushed bed-bugs bacterial cultures were obtained which caused typical tuberculosis when inoculated.[40]

Flies have sometimes been known to disseminate anthrax and other germ diseases. It is also claimed that they eat and disseminate tuberculous sputa, that the germ may be found in their bodies[41] and that fly specks carefully removed from the material to which they clung and injected have caused tuberculosis in guinea pigs [42].

A cook in removing a glass sputum cup broke it and a splinter of the glass punctured her finger. Two weeks later a swelling appeared, which grew until finally amputation was necessary. Examination showed numerous miliary tubercles containing the characteristic tubercle bacilli[43].

A young surgeon, Laennec[44] by name, had a somewhat similar experience. He wounded the index finger with a saw blade while cutting a tuberculous vertebra. A small rounded tumor with the physical characteristics of tubercle appeared at the spot and was removed.

Dr. Eve[45] relates the cases of two children circumcised when eight daysold in the Jewish manner by a tuberculous rabbi. In one case at six weeks tubercular swellings developed and in five months caseous abscesses formed, the material of which injected into guinea pigs induced general tuberculosis. The other child showed similar symptoms.

Dr. H. C. Ernst[46] stated that he "had here something like two thousand references to articles written in all languages, and in different parts of the world, bearing upon and proving the infectious nature of tuberculosis, including only the literature extending over about the past seven years."

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[37] Gazette Medical de Paris, No. 17, 1872.

[38] London Medical Record, July 15, 1884.

[39] Buffalo Med. and Surg. Journ. June, 1890.

[40] Cressy: Report on Sanito-Veterinary Investigations · 27th An. Report Conn. Bd. Agr. p. 24.

[41] Spillman and Haushalter: La Semaine Medical, Oct. 15, 1887; also Gazette hebdom. de Med. et de Chir.

[42] Hoffman: Deutsche Med. Zeit. July 16, 1889.

[43] Tscherming: Progress Med. 1885.

[44] Abhandlungen von den Krankheiten der Lungen, Leipzig, 1832. Said to be the first recorded successful inoculation with tuberculous matter.

[45] Lancet, Jan. 28, 1888,

[46] Hearing on the "Dangers to Human Life from Bacilli of Tuberculosis in Milk" before the Committee on Public Health of the Massachusetts Legislature of 1891.

*Human and Bovine Tuberculosis are identical.* The germs, the lesions, and in many respects the symptoms are the same. Lower animals inoculated with the tuberculous products of man contract the disease, the results are precisely the same as when the products of other animals are used, and the microscope shows the same germ present. Dogs, cats and poultry have in many cases on record[47] become infected from eating human sputa, while guinea pigs inoculated with fresh or dried sputa, or forced to inhale the dust of dried sputa, have succumbed to tuberculosis. There is no reason to believe that larger animals may not as readily be infected in the same manner.

*Human tuberculosis infects the lower animals*, and, what is vastly more important, and the central fact which prompts the publication of articles of this nature, BOVINE TUBERCULOSIS INFECTS MAN.

## BOVINE TUBERCULOSIS TRANSMISSABLE TO MAN.

It is obvious that direct experiment on man with tuberculous material from the lower animals is out of the question. There are on record, however, a number of cases of accidental infection of human beings by the products of tuberculous cattle. There is reason to believe that countless thousands of deaths have occurred due to this source of infection, which have not been thus ascribed and of which no record has been made. Children are more likely to be infected than adults, owing to their tissues being less resistant and because their chief food is milk. It should not be inferred, however, that disease and death of necessity follow the consumption of tuberculous meat or milk. The following are some of the authenticated cases of accidental infection which have come to our notice. It is not to be inferred that they are of necessity all or the strongest on record.

Dr. Anderson of Seeland, reports a case of a babe fed on the milk of a cow having tuberculosis of the udder. The child died at six months with tuberculosis. The mother also developed symptoms of the disease after the child's birth. It was considered that both contracted the disease from the cow's milk.[48]

Ollivier,[49] at a meeting of the Academie de Medicine of Paris, stated that a patient of his, a young woman twenty years old, of vigorous health and without constitutional trouble, had acute tubercular meningitis (inflammation of the membranes of the brain of tubercular origin). She had been educated at a boarding school where thirteen pupils had been ill of and six had died of tuberculosis within a few months. The milk supplied to the school was from cows kept on the place. Upon examination these animals were found to have tubercular ulcers on their udders, and, after being slaughtered were found to be generally tuberculous.

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[47] Peters; Vet. Journal XVIII, 1887, p. 394: Nocard; Recueil de Med. Vet. annexe, 1888, 537; *ibid*, 1889, 66; *ibid* 1885 annexe, 93: LaMallerée; La Semaine Med. 1888, and others. See also 6th and 7th Reports Bureau of Animal Industry, 1888-1890. p. 47-48.

[48] Hatch Exp. Station of Mass. Ag'l College, Bul. No. 3, p. 15.

[49] Bacteriological World, Aug. '91, translated from Allgem. Med. Cent. Zeit.; also La Semaine Médical, Paris, Feb. 25, 1892.

A Scotch family, all of sturdy health, had a herd of cattle which developed tuberculosis. Two daughters, being young, were brought up on the milk. Their two older brothers were more fond of whiskey than of milk. They are living healthy and hearty, while their two sisters are lying in their graves, victims of tuberculosis[50].

In the practice of Dr. Stang of Amorback, a well-developed five-year-old boy, from sound parents, whose ancestors on both sides were free from hereditary taint, succumbed, after a few weeks illness, with acute miliary tuberculosis of the lungs and enormously enlarged mesentric glands. A short time before the parents had their family cow killed and found her the victim of advanced pulmonary tuberculous[51].

Dr. Demme records the cases of four infants in the Child's Hospital at Berne, the issue of sound parents, without any tuberculosis ancestry, that died of intestinal and mesenteric tuberculosis, as the result of feeding on the unsterilized milk of tuberculous cows. They were the only cases in which he was able to exclude the possibility of other causes for the disease, but in these he was satisfied that the milk was alone to blame[52].

The infant son of a college mate of one of us, a comparatively strong and healthy child of twenty-one months, visited his uncle for a week. While there he drank the unsterilized milk of a cow which was soon after condemned and killed in a state of generalized tuberculosis. A few weeks after his return the child began to fail, and died three months after the fatal visit, a mere skeleton, with tabes mesenterica, or consumption of the bowels. Both of the child's grandfathers had died of tuberculosis when over sixty years of age, as well as two grand aunts and one grand uncle. The child never saw but one of these, and him but two or three times, and for short intervals only. A second child brought up on[53] sterilized milk is in robust health. Both parents are in excellent health.

A child four years old, great grandson of Henry Ward Beecher died last March at Yonkers, N. Y., of tubercular meningitis. The diagnosis was confirmed by specialists. There were no hereditary tendencies to the disease known. The certainty that he had the disease, and the inability to account for it from human agencies, led the physicians to suspect the milk of two Alderney cows, on which the child had been mainly fed. Both the tuberculin test and the post-mortems showed that both animals were tuberculous. Through the kindness of Dr. J. S. Lamkin of Yonkers, who made both tests and post-mortems, sections of the lungs and a gland were sent to us. They were found to be highly tuberculous[54].

May 30, '79, a cow died of generalized tuberculosis in Providence, R. I., the lungs, most of the abdominal viscera, muscular tissue and udder being tuberculous. The milk had been used in the family. In August, the baby was taken sick and died in seven weeks of tubercular meningitis. Postmortem showed tubercular deposits in the membranes covering the brain, and some in the lungs. Two years later a two-year-old child in the same family died of tubercular bronchitis, and seven years later a nine-

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50. Discussion on Tuberculosis, Meeting Nat. Vet. Assn. London, May '83; Extracted from Lecture to Md. Sanitary Council by Dr. Robt. Ward, 1886, p. 10.

51-52. Law: Cornell University Exp. Stat., Bul. No. 65, p. 187.

53. Private letter to J. L. H.; also reported by Law, *ibid.* p. 187.

54. N. Y. Sun, March 29, '94. Also private letters to J. L. H.

year old boy, "delicate" for years, died of "quick" consumption. So far as known the family on both sides were rugged and healthy[55].

Dr. H. M. Pond[56] reports four cases of tuberculosis in one family, of which three were fatal. He considered the milk of their cows to be the source of the disease, since those animals were apparently tuberculous.

In the spring of 1890, Dr. Gage, city physician of Lowell, Mass., had as a patient an infant which died of tubercular meningitis. Its parents were healthy, and surroundings good. It had never been fed anything but the milk of a single cow. The cow's milk was microscopically examined and found to contain the bacilli of tuberculosis. Guinea pigs inocculated with her milk developed the disease. A second child, fed upon the same milk, was developing similar symptoms to those discovered in the child that died. Dr. Gage could find no way to prevent the sale of the milk unless he bought and paid for the cow out of his own pocket. So far as he knew she was still being used for a milk supply a year later[57].

The following cases of infection from eating meat or direct inocculation may be cited[58]. A woman whose ancestors were without tuberculous taint, ate eleven chickens bought from a neighbor. These chickens had been in the habit of greedily eating the spittle of their consumptive owner. They were but slightly roasted before eaten. The woman soon developed a well-marked case of tuberculosis of the bowels.

Dr. Treon[59] describes the poor, emaciated, diseased animals furnished to the tribes of Northwestern Indians, how they eat the liver, tallow and entrails raw and fresh, and how the carcass is dried, pounded and packed in skins to be eaten later, uncooked, even though the animal died of disease. The Indian mortality from consumption is 50 per cent. of all deaths at several points, while at Crow Creek, Dakota, 50 out of the total Indian population of 1200 die yearly of consumption and scrofula[60].

Dr. Washington Matthews[61] spent twenty-one years among the Indians. He states that their food is the primary cause of disease among them, and that when the supply of fresh beef is liberal the consumption death rate is highest.

A gentleman after eating something infected with tuberculosis has a nodule of tuberculous tissue form upon his tongue[62].

Tscherming attended a veterinarian who cut his finger during a post-mortem on a tuberculous cow. An ulcerated swelling formed, which on removal proved to be tuberculous and contained the characteristic bacilli[63].

Law[64] reports a case in his personal experience precisely parallel with Tscherming's.

Pfieffer attended a veterinarian of good constitution, without hereditary predisposition; who cut his right thumb deeply during a post-mortem on a tuberculous cow. The wound healed, but remained swollen. A year later pulmonary tuberculosis had developed, and in two and a half years after the wound the man died. Post-mortem examination showed tuberculosis of the joint of the wounded thumb and of the lungs[65].

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55. Ernst: Report to Mass. Soc. Promot. Agr., p. 4; also reprint in Hatch Exp. State of Mass. Ag'l. College, Bul. No. 8, p. 16.

56. Pacific Med. & Surg. Jour. 1888.

57. Ernst: Hearing before Committee on Public Health, Mass. Legislature of 1891; Publications Mass. Soc. Promot. Agr., p. 19.

58. La Malleree;—La Semaine Med. 1888.

59. Amer. Practitioner; quoted by Law, ibid p. 131.

60. Holder;—Medical Record, Aug. 13, 1892. quoted by Law, ibid, p. 131. Scrofula is usually of tuberculous origin.

61. Census of 1880.

62. Ernst. Hearing, etc , p 6.

63-64-65. Law, Ibid. p. 318.

Dr. Ernst[66] sent a letter of inquiry to about 2000 medical men and veterinarians of the highest standing. "Out of 1200 or 1300 answers received but two expressed an absolute disbelief in milk as a vehicle for the virus of tuberculosis; there were a large number who expressed their belief in it; a large number who stated, what is perfectly true, the difficulty of proving such a thing, but expressed their belief in it; and a comparatively small number who furnished me with cases which they believed were distinctly traceable to the milk coming from tuberculous cows.

I have records of cases of probable infection of children from the milk of mothers with tuberculosis of the lungs and mamma. I have cases of the infection of chidren from milk coming from tuberculous cows. I have a large number of cases from veterinarians showing the infection of calves from tuberculous cows; and it seems to me that the amount of evidence obtained from the clinical side is very great."

Dr. E. O. Shakespeare, Ex. U. S. Cholera Commissioner says "With all its terrors, it (cholera) is not nearly so deadly as is tuberculosis," [67] and "It has been found that in infants and young children in some large cities the mortality from some form of tuberculosis is far greater than is generally believed, amounting, in some localities, to one-fifth of the deaths in the young. The significant fact in this connection is that it is most frequently some part of the digestive passages that became first affected."[68]

In this connection by way of negative evidence it is interesting to compare the geographic distributation of cattle and tuberculosis. Dr. E. F. Brush[69], of Mount Vernon, N. Y., has given years of study and investigation to this matter, and in his papers, scattered through the New York Medical Journal, makes the statement that tuberculosis does not exist among people which do not employ milch cattle. The inference to be drawn is not that human tuberculosis comes mainly from cattle, for man gets his infection mostly from his fellow man, but that possibly the primary source of infection, and more or less of its maintenance and extension are due to cattle. Whatever be the inference, there is little question that human consumption is relatively less prevalent in countries where there are few or no cattle, (Hebrides, Iceland, Newfoundland, Algiers, interior Southern Africa, parts of Ecuador and Peru and islands of the Pacific) and where reindeer, (Northern Norway, Sweden, Finland, Lapland, Greenland) goats or mares (Kirghis Steppes) furnish the milk. In some of the western South American countries cattle are used only for beef, since "so many cases of consumption have been traced to its (milk) use, that the entire population (of Eastern Peru) with scarcely a single exception, leave it entirely alone"[70].

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[66] Ernst, ibid, p. 9.

[67] Report 4th Annual Meeting Farmers Inst. New Castle Co. Delaware, p. 16.

[68] Medical News, March 26, 1892.

[69] N. Y. Med. Jour.; "Bovine Tuberculosis," March 24, '88, pp 314-317; "The Relationship existing between Human and Bovine Tuberculosis," June 15, '89, pp. 645-650; "On the Coincident Geographical Distribution of Tuberculosis and Dairy Cattle," March 8, '90, pp. 253-256, "Sterilized Milk," June 20, '91, pp. 719-721; "One of the Apparent Reasons why Man is afflicted with Tuberculosis," Dec. 10, '92, pp. 657-659.

[70] De Kalb in "Nation." Quoted by Bact. World, I-3 p. 217.

*Is the milk of a cow dangerous if the udder is not affected?* Authorities differ. Koch[71], Nocard[72] and others failed to infect animals with milk from tuberculous cows whose udders were unaffected. On the other hand, Bang[73], Bollinger[74], Hirschberger[75], Ernst and Peters[76], Smith and Kilbourne[77] and Law[78] have succeeded in infecting animals with the milk of tuberculous cows with apparently sound udders. In Bang's work most pains-taking microscopical examinations of the udders of six cows giving infectious milk failed to show lesions. The conclusions drawn by Ernst and Peters from their careful wórk at Mattapan, Mass., are:

*1st. And emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.*

*2d. That the virus is present whether there is disease of the udder or not.*

*3d. That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.*

*4th. That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk of cows affected with tuberculosis but with no discoverable lesion of the udder.*

The fact that bovine tuberculosis may be transmitted to lower animals is absolutely proved by hundreds of positive experiments, and that it may likewise infect human beings through association and by their consumption of meat and milk, while not proved by direct, positive, intentional experiment, is placed practically beyond doubt by many observations of accidental infection.

*Càn the germ be killed and tuberculous meat and milk be made safe to eat by cooking?*

The beef muscle is seldom affected, but the small lymphatic glands between the muscles, commonly cut and eaten in steaks and roasts are often diseased. The flesh itself of the pig is affected, and tuberculous pork is much more dangerous than tuberculous beef. The interior of a rare roast or steak is not heated to a point to insure safety, but all germs in a well-done or well-boiled piece are usually killed.

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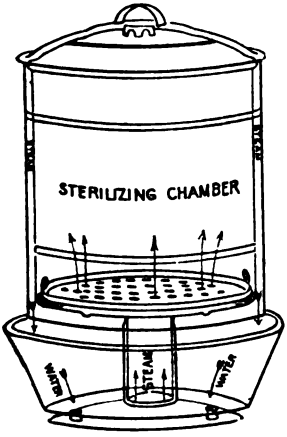
71. Loc cit.
72. Recueil de Med. Vet. annexe 1885, p. 49.
73. Deutsche Zeit f. Thiermed XI 45, 1885, also Congres pour l'etude de la Tuberculose 1888.
74. Deutsche Zeit f. Thiermed XIV 261.
75. Deutsche Arch. f. Klin. Med. XLIV 500; also Internat. Klin. Rundschau, Sept. 22, '90.
76. Trans. Assoc. Amer. Phys: IV, 1889. Report to Mass. Soc. Promot. Agr.; Hatch Agl. Exp. Sta. Bul. 8.
77. Bureau of Animal Industry, Bul. 3; also 8th and 9th Reports same, p. 64.
78. Cornell Univ. Exp. Stat., Bul. 65, p. 186.

If milk be boiled for half an hour, or heated by steam to 212°F practically all germ life will be destroyed. If heated to 150° to 167°F for half an hour to an hour and then cooled (rapidly if possible), the growth of such disease producing germs as are not killed is retarded for a period of twenty-four hours or more. The albumen is not coagulated at these temperatures, the milk is more palatable and digestable than if sterilized and is practically safe for prompt use. Pasteurized milk will not keep quite as long as sterilized milk. *Either sterilization or pasteurization is highly desirable with milk intended for children*, and is not a serious task. If bottles, one-half to three-fourths full of milk, are steamed for half an hour in a common steamer on the kitchen stove, all disease germs will be killed. The mouths of the bottles should be then plugged with clean absorbent cotton or cotton wool, as soon as removed from the steamer in order to keep all germs out. Half pint beer bottles with patent stoppers, costing sixty cents a dozen, are used in the family of one of us, and the milk is pasteurized with the stoppers closed as suggested by Cary[19]. A good milk sterilizer complete may be bought for from two to three dollars.

Three different models of milk sterilizers are shown herewith. The "Arnold" sterilizer (A) is made by Wilmot Castle & Co., 14 Elm St., Rochester, N. Y., and sells, with bottles, for $2.50. A recent modification of this apparatus enables pasteurization or sterilization in the same apparatus. The sterilizer recommended by Cary is shown at B. A copper sterilizer of this pattern with six patent stopper bottles (shown in cut) made to order in Burlington cost $2.30. The third cut (C) is kindly loaned by the Bureau of Animal Industry, and illustrates a yet cheaper but effectual form of sterilizer.



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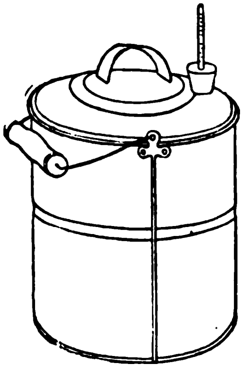

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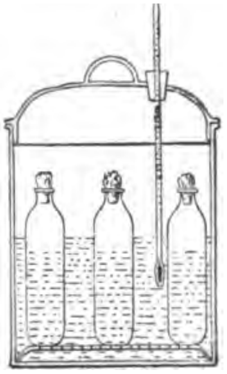

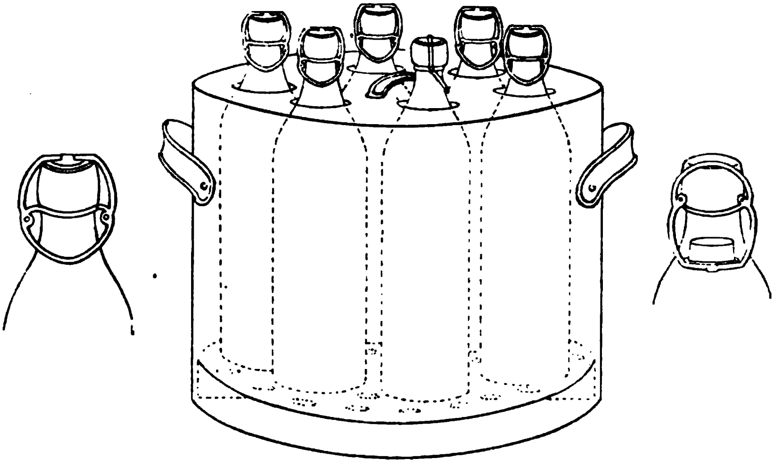

B

Dr. Law[80] points out a hitherto unappreciated source of danger in the use of the products of tuberculous animals even after complete sterilization. He draws a distinction between tubercular poisoning and tubercular infection. The product of the life of the tubercle bacillus is tuberculin. Its ptomaines, being lifeless, are not killed, but are intensified by heat. This material being generally diffused throughout a tuberculous subject exists in its products. Hence, those consuming its products, even though they are sterilized, are taking small doses of tuberculin, and, if they are already tuberculous, the effect may be to stimulate and extend the disease. The transmission of the germ is admitted to be more common from man to man than from animal to man. Though thus implanted, its subsequent destructive progress may be largely due to the constant accessions of the soluble poisonous products of tuberculous meat and milk, without which the implanted germ might have lain dormant. The reasoning from known facts is logical, and Dr. Law's point seems well taken. If this be true, it goes far towards explaining why tuberculosis is comparatively rare in countries where cattle are few. It tends to place the blame for the extension, if not for the inception of disease upon the bovine species.

Were it not for the use of tuberculin as a diagnostic agent the consumer might be considered to be between the devil and the deep sea, with tubercular infection on the one hand and tubercular poisoning on the other.

*The reader should neither infer that there is of necessity more bovine tuberculosis now than in years past, nor that the danger to human life is greater. If some of the customs of modern life have increased our dan-*

79. Alabama Agl. Exp, Station. Bul. 53.

80. Ibid. p. 138.

*gers, others have decreased them. We are hearing more about tuberculosis now than ever before, simply because we know more about it. But so long as the human death rate from this disease remains at its present height, it will be profitable to continue to discuss measures for its prevention. Nor should our dairymen and breeders become needlessly alarmed. Probably not one animal in thirty throughout the State has the disease, and there are thousands of herds entirely free. What we need is simply that all realize the nature and conditions of the disease and of its spread. This done they can breed and care for their stock understandingly, weed out suspects at once, disinfect where needed, in short, use all possible precautions to avoid the disease. To this end a full, free, temperate and intelligent discussion is invited.*

*Is bovine tuberculosis curable?* The usual opinion is that treatment is of little avail, that it is troublesome and costly, and that the results are unsatisfactory. Some believe that climatic change benefits cattle as it does mankind. It is true that the steers of the high altitudes of the West are practically free from this disease It is doubtful, however, whether it would pay to try climatic change upon many animals or whether Western stock owners would admit confessedly tuberculous animals among their hitherto unaffected stock. The proverb "An ounce of prevention is worth a pound of cure," is applicable to this disease. We may look forward to curative measures in the future, but at present the means are not known.

## 8. PREVENTION.

Since the results of curative treatments are unsatisfactory, and prevention is the watchword, *how may the disease be most surely prevented? Both human and bovine tuberculosis are distinctly preventable.* The measures that may be taken to prevent its spread are, briefly :

*1. Rigid official inspection of cattle, meat and milk.*

*2. The immediate destruction or sterilization of human sputa and all tuberculous discharges.*

*3. The careful disinfection of rooms, hospital wards, barns, etc., occupied by tuberculous men or animals.*

Though thus briefly summed, the execution of these measures involve a mass of details. Sumptuary laws are always difficult to enforce and questions of possibility and expediency should enter into consideration before enactment. "The fountain cannot rise higher than its source," and until the people thoroughly appreciate the dangers and understand the cause and means of prevention of tuberculosis, its control will be difficult.

The following precautions will be found useful by the stock owner in weeding out or keeping out tuberculosis.

1. The cow stable should be light, well ventilated and dry, the water pure and fresh, the feed nutritious and plentiful, the breeding judicious, with due regard to constitution.

2. So far as possible cattle should be kept from licking each other, from eating from the same manger and from interchange of mangers.

3. Suspected animals should be isolated, should neither eat nor drink from a common manger or drinking trough, nor should their orts be fed to other cattle. Old cows, those having husky or rattling cough, wheezy breathing, nasal discharge, enlarged glands under the skin, diseased udder, garget (sometimes), diseased joints, etc., unthriftness in general, cattle with weak constitutions and poor physical conformation (narrow chest, light barrel, long legs, pot bellies, etc.), are most open to suspicion. Such animals should be examined by a skillful veterinarian, and in case of doubt should be tested with tuberculin. If a single animal shows tuberculosis, the whole herd should thus be tested.

4. No new animal should be admitted from herds in which contagious disease has existed, from city or swill stables, or that shows signs of disease or unthriftness, unless tuberculin tested. It is almost equally desirable that unsuspected animals also be thus tested.

5. No consumptive person should work with live stock or prepare their food.

6. All tuberculous animals should be killed and their carcasses either burned or deeply buried in places where animals have no access.

7. Disinfection should be thorough and extend to all products of and articles used by the cattle. The means used at this Station were burning sulphur in the closed stable, washing or spraying every square inch of surface with a solution of one part corrosive sublimate in one thousand parts of water and the replacing of all the wood-work of the mangers. *Corrosive sublimate is a violent poison and should be used with care.*

The following directions for disinfection will be found useful in cases of animal disease:

1. Remove and burn all loose litter, hay, rubbish, etc.

2. Wash all mangers, hay racks and all wood work with a dilute solution of corrosive sublimate as stated above.

3. Whitewash all the inside of the building, especially mangers, hay racks, etc., and all wooden utensils used in the barn with a white wash containing one pound of chloride of lime to four or five gallons of water.

4. Remove and burn all rotton wood work, particularly about the mangers, drinking troughs, etc. It is advisable to replace these even if sound.

## 9. RELATION OF THE STATE TO TUBERCULOSIS.

The relation of the State to contagious and infectious animal diseases is a question on which there is wide diversity of opinion and practice. The most effectual work in the suppression of animal disease is that done under governmental supervision since it is more apt to be done in a systematic, intelligent and thorough manner. The National government has recently stamped out contagious pleuro pneumonia in cattle, but tuberculosis is wide spread, more insidious, more difficult to diagnose and cannot be thus easily handled. The experience of other States in this matter may prove instructive.

We have obtained this data by correspondence with the officials in charge of this work in the various States.

Maine, New Hampshire, Massachusetts, Maryland, Ohio, Indiana, Illinois, Michigan, Kansas, Colorado and Missouri have Boards under various names, essentially Cattle Commissions. In Vermont, Rhode Island, Connecticut and Pennsylvania the Boards of Agriculture, or a committee of the same, act as Cattle Commissioners. In New York, New Jersey, Minnesota and Tennessee the State Boards of Health attend to this matter. Most of the Southern states and some of the far Western states exercise no control whatever over animal disease. Some of the Boards have veterinarian members, some do not. All however employ veterinarians.

Data was obtained from all the States having controlling boards east of the Mississippi, with the exception of Wisconsin.

| State. | Does State law especially mention tuberculosis; if so in what way? | Is it customary to give indemnity; if so how much? How is apprisal made? | How does Board regard indemnity system. | How does Board handle tuberculosis if reported? | Do you use tuberculin? How do you like it? Do post-mortems confirm test. |
|---|---|---|---|---|---|
| Ontario, Canada. | Yes, as an "infectious or contagious disease." | Not in Ontario. In certain circumstances the government grants compensation. | Favorably. | Same as other diseases. | Yes, approve. Post-mortems always confirm. |
| Maine. | Especially tuberculosis. | Yes; half limited apprisal. | Highly favorable. | Same as other diseases, inspection, apprisal etc. | Yes, very much, invariably. |
| New Hampshire | Especially tuberculosis. | Yes; half limited apprisal. | Favorably. | | Yes, well, reliable. |
| Vermont. | No. | Law permits; present Board have only given for glanders | Unfavorably. | Free veterinary service and free tuberculin, but no indemnity. | Yes, much, yes. |
| Massachusetts. | Yes, special act. | Half limited apprisal. | Not very favorably. | Examination and slaughter if affected. | Not as a Board. |
| Rhode Island. | Yes, section 10 chapter 1082. | Yes; half limited apprisal; three apprisors one being commissioner and one veterinarian. | Favorably. | Same as other diseases. | Not as a Board. No. No. |
| Connectic't | No. | Yes, actual sick value; 3 appraisors; 1 named by owner, 1 by State, 2 choose 3d. | | Investigate, as with other disease. | Yes, in one herd. Results satisfactory. |
| New York. | Yes, special act. | Yes; apprisal by owner's selected apprisors; referred to court of claims. | | With glanders by State Board Health, while other contagious cattle diseases are handled by Com. of Agriculture. | Yes, 20,000, injections. Liked well. 3½ per cent. cattle tested found tuberculous. |
| New Jersey | No. | Half limited disinterested apprisal. | | | Not as a Board. |
| Penns'lvna | No. | Yes; limited apprisal. | Highly favorable, "would not undertake to enforce a law without." | "Use tuberculin; 'advise' slaughter; do not condemn for then we have to pay. They are killed in 90 per cent. of cases." | Yes; "safe in proper hands" "known of no error but will accept from no one but our own surgeon. Post-mortems have in all cases shown the disease". |

| State. | Does State Law especially mention tuberculosis, if so in what way? | Is it customary to give indemnity; if so how much? How is appraisal made? | How does Board regard indemnity system? | How does Board handle Tuberculosis if reported? | Do you use Tuberculin? How do you like it? Do post-mortems confirm test? |
|---|---|---|---|---|---|
| Maryland. | No. | No. | Favorably if under national auspicies. | Report it to State Board Health. | Not yet. Awaiting development of use elsewhere. |
| Ohio. | No. | No. | No funds. | Do not handle. | No. |
| Indiana. | | No. | No funds. | Only handled few cases. | No. |
| Illinois. | No. | Glanders only. | Favor indemnity at sick value. | Only handled few cases. | No. |
| Tennessee. | No. | Yes. | Favorably. | No. | No. |
| Michigan. | | | | | |
| Minnesota. | No. | No. | Unfavorable. | Isolate, use tuberculin and forbid sale of products or as food. | Yes. Supply it to local boards. |
| Kansas. | No. | No. | Not considered. | Not recognized by law as contagious. | Not as a Board. |
| Colorado. | No. | Yes; limited appraisal by 3 disinterested appraisors; 1 furnished by State and 2 choose 3d. $1000 in a year is State limit. | "Absolutely necessary in order to detect existence of disease and have it reported." | State is free from tuberculosis. | No. |
| Oregon. | | | | | Yes. Yes. |
| Missouri. | Yes. Law enables quarantine. | Only for glanders. | Favorable. | Inspect, and if infected quarantine. | Not as a Board. |

Of the states having occasion to deal with bovine tuberculosis which reported, six pay little attention to it. New York, Pennsylvania and Minnesota have taken the most advanced grounds regarding its suppression. Of the fifteen State Boards answering the question regarding the opinion held by the Board of the indemnity system, nine were favorable to it, three did not consider it owing to lack of funds, and three did not favor it. Maryland, Ohio, Indiana, Minnesota, Missouri, Kansas, the Southern States and most of those of the far West have no indemnity system, while the laws of all the New England and Middle States permit it.

The arguments for and against the indemnity system may be summed up briefly as follows:

1. The indemnity system encourages the disclosure of the existence of disease and favors its more complete eradication, while the absence of some

such system leads to the concealment and dispersion of disease. In many cases the comparatively small expenditure for indemnity distributed among many tax payers is truer economy than the losses in life and money, caused by animal diseases which have been concealed.

2. The indemnity system recognizes the rights of property.

3. Since the public is benefited in being guarded against disease, it should bear its share of the cost of that protection.

On the other hand:

1. The indemnity system is apt to encourage disease. The stock owner is less careful if he can rely on the State to purchase his infected animals, even though at a low rate.

2. Diseased animals are often collected at a low figure from other owners and other States for the purpose of getting indemnity from the State.

3. It is liable to become a burden to the tax payer.

4. The State essentially insures breeders and owners against their mistakes and misfortunes. While it is hard to lose property in any form, a diseased animal is a nuisance. There should be no question between a loss of dollars and the not improbable ruin of the health of human beings.

From the standpoint of disease eradication only, there is no question that a liberal indemnity promptly paid is preferable to any other course.

The Bureau of Animal Industry of the Department of Agriculture at Washington, is employed in a thorough investigation of tuberculosis, using a special appropriation of $100,000 for the purpose. An English Parliamentary Commission has been considering the matter for nearly three years and is expected to report this year. The Danish government has taken an advanced stand, and in April 1893, appropriated $13,000 for the purpose of inaugurating a thorough system of tuberculin tests throughout the Kingdom. Disinfection and separation are to be used and a strong fight against bovine tuberculosis will be made.

The Legislature of 1892, abolished the board of cattle commissioners and placed the execution of the statutes regarding cattle diseases in the hands of the State Board of Agriculture. The following circular has been issued by that Board explaining their attitude towards tuberculosis, copies of which, with bond, may be obtained of any of the members of the Board on application.

OFFICE OF CATTLE COMMISSIONERS,

BRANDON, VT.

*Dear Sir:*

The attention of cattle owners, and the public generally, is being attracted towards the disease called Tuberculosis. This is a very old disease among cattle, dating to the Middle Ages, and is almost identical with consumption in the human family, and is transmittable, under favorable con ditions, from the human family to cattle, and from cattle to the human family by means of the germs of disease contained in the sputum thrown from the lungs in coughing. It is also claimed that the disease is conveyed to the human family by the use of the dairy product of tuberculous cows, the truth and extent of which is now being tested by experiments. The disease is usually of slow progress and difficult to detect by exterior appearance except in advanced stages, or when located in the lungs.

It has recently been claimed by scientists that Koch's Lymph, called Tuberculin, is a means of detecting the disease, even when not apparent from any outward test.

The Bureau of Animal Industry offers to furnish a limited amount of the Lymph to the different Experiment Stations and Cattle Commissions, provided they will slaughter such cattle as the Lymph indicates have the disease, and report to Washington.

There are at the present time many experiments being made to test the danger to the human family from the use of the dairy product of tuberculous cows; also to test the efficacy of the Lymph as a certain and safe guide for its detection.

On account of the unsettled conditions connected with this disease, the Board of Cattle Commissioners do not feel warranted in taking extreme grounds, but are willing to aid science in offering the services of an expert in applying the tuberculin to any herd where it may seem advisable —provided the owner of such herd will agree to slaughter and allow the examination of all that respond to the tuberculin test, without compensation from the State.

C. M. WINSLOW,
VICTOR I. SPEAR,
J. O. SANFORD,
H. W. VAIL,
J. L. HILLS,
H. M. ARMS,
} Board of Agriculture.

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OFFICE OF CATTLE COMMISSIONERS,
BRANDON, VT.

*Dear Sir:*

In consideration of free veterinary services and free use of tuberculin supplied by the State Cattle Commission, in response to my application to them for inspection of my dairy herd, I do hereby agree—

To slaughter all animals declared by the veterinarin to be tuberculous, at such time and place as he shall appoint; to allow him to make post-mortem examination of such slaughtered cattle; to afford him such assistance in slaughter and preparation for post-mortem as he may require—with the distinct understanding that I shall not hold the State of Vermont, or any person or persons, or the Board of Cattle Commissioners, individually or severally, liable for payment for any animal or animals so slaughtered.

Signed,

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Witness.

## V. BIBLIOGRAPHY.

The following list comprises all the publications on the general subject of tuberculosis issued by American Experiment Stations, the Bureau of Animal Industry of the Department of Agriculture, and most, if not all, of those issued by the Cattle Commissions of the New England and Middle States and Ontario. Most of these publications, (if in print) may be obtained free upon application.

### EXPERIMENT STATIONS.

*Delaware* (Newark)—Fifth Annual Report. Consumption in Milch Cows (Bovine Tuberculosis); A. T. Neale; pp 49-52, 3 pages.

*Maine* (Orono)—Annual Report 1890, Part II.; Report on Tuberculosis; F. L. Russell; pp 59-64 6 pages.

Bul. No. 13, June 1894; The suppression of bovine tuberculosis and glanders; F. L. Russell, 7 pages.

*Massachusetts*, (Hatch Station, Amherst)—Bul. No. 3, Jan. 1889; Tuberculosis; C. H. Fernald; 20 pages.

Bul. No. 8, April 1890; How far may a cow be tuberculous before her milk becomes dangerous as an article of food. Extract from Report to Mass. Soc. Promote Agr.; H. C. Ernst; pp 13-24, 12 pages.

*New Jersey* (New Brunswick) Bul. No. 101, July, 1894, also Annual Report, 1893; On the Use of Koch's Lymph in the Diagnosis of Tuberculosis in Cattle; J. Nelson; 77 pages, 5 plates.

*New York*, (Cornell Station, Ithaca)—Bul. No. 65, April, 1894; Tuberculosis in relation to Animal Industry and Public Health; James Law; pp 103-157; 54 pages.

*Pennsylvania* (State College, Centre Co.)—Bul. No. 21, October, 1892; The Koch Test for Tuberculosis; H. P. Armsby and L. Pearson; 19 pages.

*Vermont* (Burlington)—Bul. No. 42, July 1894; Bovine Tuberculosis; J. L. Hills and F. A. Rich; pp 17-70, 54 pages, 4 plates:

*Virginia* (Blacksburg)—Bul. No. 26, March, 1893; Tuberculosis and the Koch Test; E. P. Niles; pp 55-60; 6 pages.

Bul. No. 32, Sept. 1893; The cow in relation to public health; E. P Niles; pp 119–126, 6 pages.

*Wisconsin* (Madison), Bul. No. 40, July 1894; Tuberculosis and the Tuberculin Test; H. L. Russell; 47 pages.

*Canada* (Ottawa, Ontario)—Bul. No. 20, February, 1894; Tuberculosis; Wm. Saunders and J. W. Robertson; 36 pages.

### UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY, WASHINGTON, D. C.

First Annual Report (1884); Report on Tuberculosis, International Veterinary Congress, Brussels, 1883; pp 350-366, 17 pages.

Fourth and Fifth Annual Reports (1887-1888); Various items concerning tuberculosis; p 499, 1 page.

Sixth and Seventh Annnal Reports (1889-1890); Tuberculosis in Domesticated Animals; pp 45-62, 17 pages.

Eighth and Ninth Annual Reports (1891-1892); Experiments with the milk of tuberculous cattle; pp 63-65, 2 pages; Tuberculosis in cattle; pp 102-103, 1 page; Tuberculin; pp 106-107, 2 pages.

Special Report on Diseases of Cattle and Cattle Feeding (1892); Tuberculosis; D. E. Salmon and J. T. Smith; pp 398-408, 11 pages.

### CATTLE COMMISSIONS, ETC.

*Maine* (Portland); Reports of Commissioners on Contagious Diseases of Animals, 1888, 1889, 1890, 1891, 1892.

*New Hampshire* (Concord); First and Second Annual Reports of the State Board of Cattle Commissioners of New Hampshire, 1891, 1892.

*Vermont* (Brandon); Fourteenth Annual Report of the State Board of Agriculture, 1893-94; see also (Brattleboro) Report of the Twenty-second Annual Meeting of the Vermont Dairymen's Association (1892); Tuberculosis; Dr. Austin Peters.

*Massachusetts* (Boston); Reports of Cattle Commissioners in Reports of State Board of Agriculture, 1880, 1886, 1887, 1889, 1891, 1893.

*Rhode Island* (Providence); Report of State Board of Agriculture, 1892.

*Connecticut* (West Cornwall); Reports of Commissioners on Disease of Domestic Animals in Reports of State Board of Agriculture, 1879 to 1893 inclusive; Reports for 1879 and 1887 also contain addresses on the subject by Dr. N. Cressy.

*New York* (Albany); Report of State Board of Health, 1891, 1892, 1893.

*New Jersey* (Trenton); Circular 50, State Board of Health; Reports of State Board of Health in Reports of State Board of Agriculture, 1891, 1892, 1893.

*Pennsylvania* (Harrisburg); Reports of State Board of Agriculture, 1885, 1886, 1891, 1892.

*Delaware* (Newark); Reports of the Third (1892) and Fourth (1893) Annual Meetings of the Farmers' Institute of New Castle Co.

*Ontario* (Toronto); Report on Tuberculosis in Ontario, presented to the Provincial Board of Health, etc., by P. H. Bryce, Secretary; the Milk Supply Problem, by P. H. Bryce, Secretary; Diagnosis of Tuberculosis by J. J. MacKenzie.

# 1894.

# VERMONT

# AGRICULTURAL EXPERIMENT STATION.

# BULLETIN No. 43.

NOVEMBER, 1894.

## Household Pests.

I. BUFFALO BEETLE. (Pages 73–76.)
II. CLOTHES MOTHS. (Pages 76–78.)

BURLINGTON:
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# BULLETIN NO. 43. HOUSEHOLD PESTS.

By G. H. Perkins.

## I. BUFFALO BEETLE.

The *Buffalo Beetle* or Carpet Beetle is sufficiently well known in most of our Vermont homes in the larva state, that in which it commits all of its depredations, but it does not appear to be well known in the perfect or beetle state and is not always recognized when seen. It is obviously important this pest should be known in all its different forms. Undoubtedly the Buffalo Beetle is a serious pest although, as is very likely to be the case, many of the reports of its destructiveness have exaggerated the facts. It is exceedingly mischievous when it infests woolens, but, although not wholly confining its ravages to this material, it does not often do much damage to other substances. It does eat feathers, furs, leather and perhaps other things, but the accounts which have been given from time to time of its destruction of silk do not seem well founded. Prof. Fernald remarks as to this.

"The opinion that it injures cotton or silk goods, lace curtains, etc., must be erroneous, for I have repeatedly put the larvae or young of this beetle into bottles with various substances for them to feed upon, and when furnished with cotton and wool mixed goods, they invariably ate the woolen fibres, leaving the cotton intact; but when I gave them only cotton, silk, or pieces of newspaper, they as invariably died without eating any of these substances. The injuries reported to have been done to silk, lace curtains, etc., must have been done by some other insect." Very possibly the other insect may be in some cases the Pitchy Carpet Beetle mentioned on a following page.

Just when the Buffalo Beetle came from Europe to this country, as it did at some time, for like the clothes moths it is originally European, cannot be ascertained. It appeared first on the Pacific coast and is believed by some to have been brought over at the time of the Spanish occupation of California. It did not appear on the Atlantic coast for many years and probably came from Europe directly, imported in woolens. As a household pest it has been known for about thirty years, but not as a very serious one so long. In Vermont it has been troublesome not more than ten years so far as I know.

Since it is important that the perfect beetles, which lay the eggs from which the larvae come, be recognized, the accompanying figures are given and by the aid of these one should be able to distinguish the Buffalo Beetle from sundry other species which have been mistaken for it.

Through the kindness of Mr. L. O. Howard, U. S. Entomologist, the cuts here given have been obtained from the Department of Agriculture. Figure 1 shows the beetle in all stages except the egg, enlarged so that its distinctive characters may be more readily seen, the little line at the side of each showing the natural length. The larva which is the form commonly seen and which is therefore most generally known as the Buffalo Beetle, because, perhaps, of its hairy appearance, is shown at *a*, upper side, and *b*, lower side. In the fall the larvæ change to pupæ within the dry larva skin. This stage, which is very rarely seen, is shown in the figure, *c*. In the spring these pupæ transform into the beetles. Out of doors these changes go on more slowly than in the house and the beetles do not usually appear before May, though they have been seen the 27th of April, according to Dr. Lintner. In a house where the temperature is always warm, times and seasons are less observed by insects than they are in the outside climate, and these beetles may appear much earlier. Dr. Lintner has found them in his office as early as the 6th of March. The perfect insect is a very small beetle, not as large as the larva, which varies somewhat in size, but is usually rather less than a fourth of an inch long, while the beetles are from 1-7 to 3-16 of an inch long and nearly as wide. The form is seen in the figure (*d*). The colors are black, white and red. By reference to the figure, the black and white patches will be readily noticed.

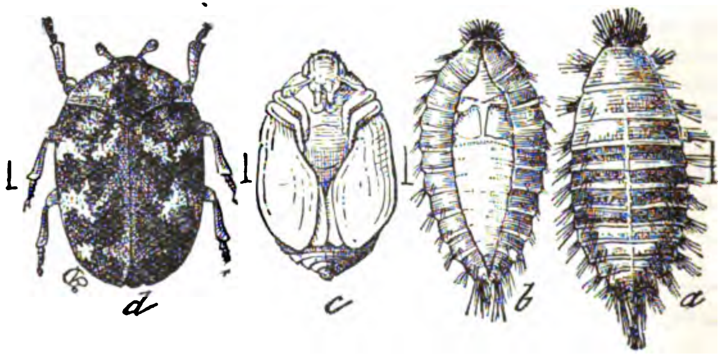

Figure 1.—ANTHRAENUS SCROPHULARIÆ, L.
Buffalo Beetle. *a* larva, upper side; *b* larva, lower side; *c* pupa, *d* perfect insect.

The red is confined to a somewhat irregular stripe along the middle of the back at the junction of the wing covers and from this are three narrowly triangular projections on each side. On the head there are also a few red spots. The antennae are quite characteristic and by them alone the beetle may be distinguished from other small beetles of different habits. They are composed of eleven joints of which the last three are much larger than the rest. The back is but little convex. The under side of the body is black dotted with red and white. The relative proportions of black and white vary considerably in different specimens and rarely the red along the middle of the back is replaced by white. It often pretends to be dead when disturbed so that if one is found apparently dead it will be just as well to kill it again.

The adult insect lives out of doors on flowering plants. It is, therefore, much less often seen inside the house than the larva. It is common on spiraea and similar plants and upon Compositae and plants of the Foxglove family. From these it flies into the house to lay its eggs on woolen substances. It seems strange that so entirely innocent and beneficial a beetle as the lady-bug should have been so often thought to be the Buffalo Beetle. I have had numerous specimens of the two-spotted lady-bug brought to me for Buffalo Beetles, though there is very little resemblance between the two.

*Remedies.* When the Buffalo Beetle has once become well established in a house it cannot be easily dislodged, but with proper perseverance and care it can be driven out and kept out from even badly infested houses. Of course if carpets fastened to the floor were not used, but only rugs laid down and often shaken there would be far less danger of injury from the ravages of the beetles, but if carpets are fastened down, a thorough lining with paper will prevent many of the larvæ, which hide in cracks and crevices, from getting at it. Tarred paper next the floor covered with some cleaner sort to prevent injury to the carpet would undoubtedly be most useful, but the odor is a serious objection. If larvæ appear, benzine may be poured about the edges of the carpet several times during the season. An excellent remedy is corrosive sublimate, 60 grains, dissolved in a pint of alcohol or water and brushed over the floor at the edges before the carpet is laid, and also over the underside of the carpet. This soon destroys any insect which attempts to eat the carpet, but children must not play upon a carpet so treated. A still simpler method which is said to be effective, is that of laying a damp cloth on the carpet at the edge where it is most likely to be infested, and then placing a hot iron on it. The steam thus produced penetrates the carpet and destroys any insects which may be within the range of its action. Insect powders are not of any value as remedies in this case.

It will readily be seen that the remedies named are as available in care of clothing and other articles as they are for carpets. Small articles and boxes, drawers, etc., may be effectually freed from insect pests by the use of benzine or bisulphide of carbon. Better than any other method, and the simplest as well, when the size of the object likely to be infested is not too great, is the wrapping it in smooth, whole paper or putting it into a paper bag and sealing the opening with paste. If this is done before the beetles have had a chance to deposit eggs upon the article, or larvæ to get at it, there is no danger that the insect will be able to reach it.

There is another small beetle which has often been confounded with the Buffalo beetle, and which is, when equally as numerous, even more more destructive. This is

*Attagenus piceus, Oliv*, which may be translated, Pitchy Carpet Beetle. It is a little larger than the one first considered. The wing covers are really black, but they are covered with brown hairs so that, as it is usually seen, the color appears to be brown. It is longer and narrower than the Buffalo Beetle. The larva is a hairy brown object with whitish rings between the joints. and at the posterior end is a long pencil-like tuft of hair. It is a lively insect, crawling rapidly when disturbed. It seems to be a more general feeder than the Buffalo Beetle and therefore is more to be dreaded. It is quite probable that some of the damage which has been ascribed to the Buffalo beetle is the work of this species.

## II. CLOTHES MOTHS.

One would suppose that an insect so long a household pest as the *Clothes Moth* would be well known ere this. But it does not seem to be so, at least in the adult or perfect state. It is not uncommon to see careful housekeepers chasing every moth that chances to fly about the evening lamp regarding neither size nor appearance. And yet it is not uncommon to find the delicate little moths about woolens that have been long infested, and very little thought would convince anyone that the much larger moths which flit about the lights cannot be the same. Moreover, every housekeeper knows that Clothes Moths prefer darkness to light and a little thought would arouse a suspicion that insects with this preference would not be likely to be attracted by lights. As a matter of fact they are not, but if they chance to be flying about they choose the darkest parts of a room. I have spoken of the Clothes Moth and there is one species which is much more common than others, but there are three species. Figure 2 is the most common and is the species the larvae of which has the habit of making for its protection a case or tube from the woolen on which it feeds.

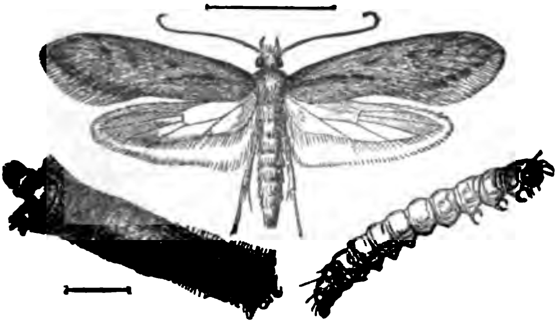

Figure 2.—TINEA PELIONELLA, L.
Full grown moth. Larva in its case. Larva without case.
All about three times enlarged.

The case is made by fastening tiny bits of whatever woolen the larva feeds upon by delicate silk threads which the larva spins for the purpose. Of course the color of the case depends upon the color of the cloth eaten when it was made. Prof. Fernald by feeding some larvæ first with blue flannel and by and by giving them red, found that when the case was enlarged, as it needs to be from the growth of the larva, this was accomplished by splitting first one end and working in a new piece, then the opposite end is split and a piece put in there. Unless compelled to do so, the larva does not leave its case. The moth is so well shown in Figure 2 that nothing need be said by way of description except as to color. The general color is light brown on the front wings and silver gray on the hind wings. On the front wings are dark brown markings shown in the

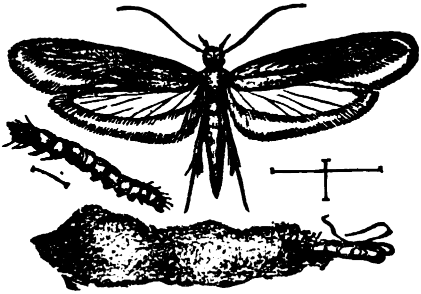

Figure 3.—TINEA BISELLIELLA, L.
Sun Moth. Larva. Cocoon much enlarged.

figure. The second species shown in Figure 3 is less common and the larva does not make a case, but when fully grown makes a cocoon, seen in the lower part of Figure 3. The moth is of about the same size as the preceding and the expanded wings are half an inch across. The general color of the moth is light yellow and there are no dark spots as in the former species.

The larva is a small white worm, with a light brown head. It is, according to Dr. Riley, the most common species in the South, but here it is usually less common than the other. In our museum collections, however, I find it much more commonly than T. pelionella. Figure 4 shows a third species though it is so very rare that it is of very little consequence economically. The larva makes no case, but burrows in whatever it feeds upon, thus making channels.

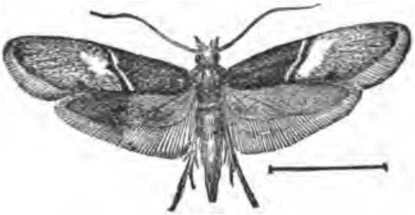

Figure 4.—TINEA TAPETZELLA, L.

*Remedies:* If clothing etc., can be enclosed in perfectly tight paper bags before moths begin to fly and lay their eggs they will be completely protected. Out of doors the moths do not appear before the latter part of May if before June in this region, and during the month of June the campaign must be vigorously prosecuted. Articles found infested or if suspected may be sprinkled or better sprayed with benzine and this will destroy even the eggs. If infested closets, drawers, etc., are thoroughly treated with benzine in June there will be little trouble during the remainder of the season. After spraying and airing, articles may be safely wrapped in papers or if possible put in bags. A few cents worth of paper bags is worth far more than costly cedar chests or closets. Furniture, carraiges or other large articles in constant use are not very likely to be attacked. If stored they should be covered with paper if this can be done so completely as to leave no opening for the ingress of moths. If this can not be done then a spraying with benzine or bisulphide of carbon early in June, and again in a month or six weeks should prevent damage. When more convenient cotton cloth may be substituted for paper in covering carriages or other objects.

# 1894.

# VERMONT

# AGRICULTURAL EXPERIMENT STATION.

# BULLETIN No. 44.

DECEMBER, 1894.

# Spraying Orchards and Potato Fields.

I. SUMMARY. (Page 81.)
II. RELATION OF WEATHER OF 1894 TO PLANT DISEASES. (Page 82.)
III. APPLE AND PEAR SCAB. (Pages 83–93.)
IV. RESULTS OF SPRAYING POTATOES IN 1894. (Pages 93–99.)
V. OBSERVATIONS UPON THE DATE OF PLANTING POTATOES. (Pages 99–100.)
VI. POTATO SCAB AND ITS PREVENTION. (Pages 100–102.)

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# BULLETIN NO. 44, SPRAYING ORCHARDS AND POTATO FIELDS.

By L. R. Jones.

## I. SUMMARY.

**II. The weather of 1894 was remarkably dry and as a result fungus diseases damaged crops less than usual. The loss from apple and pear scab was less than in most seasons. Potatoes at the Experiment Farm were practically free from blights and rot. Certain insects, especially flea-beetles and grasshoppers were unusually troublesome upon potatoes. (Page 82.)**

**III. The scabbing and cracking of apples and pears is a fungus disease. The remedy consists in spraying the trees with Bordeaux mixture. Where this was done in 1894, the market value of the fruit was increased from one-fourth to one-half. All apple and pear trees should be sprayed once or twice with Paris green to destroy the codlin moth and other insects. Those varieties liable to scab should be sprayed in April before the leaves open with a simple copper sulphate solution, and at least three times in May and June with the Bordeaux and Paris green mixture. (Pages 83–93.)**

**IV. There was no appreciable loss from blights or rot upon our potato plots in 1894. Hence the gains from the use of the Bordeaux mixture were less marked than in former years. The use of the mixture was rendered profitable, however, by its beneficial effects in other ways, especially in preventing the injuries of flea-beetles and grasshoppers. (Pages 93–99.)**

**V. Early planted potatoes in Vermont form their tubers in July. This is usually the driest month of the summer and as a result the yield is small, the plants often dying prematurely. Later planted potatoes form their tubers in August and September, months in which the rainfall is usually abundant, and the yield is proportionally large. In order to preserve these later potatoes from the blight and rot they must be sprayed. Owing to the peculiar weather of 1894, early planted potatoes yielded most and late ones least. It is believed, however, that these conditions were exceptional and that the later planting is for the average season more profitable. (Pages 99–100.)**

**VI. Potato scab is a fungus disease. Preventive measures consist in selecting clean soil, using proper fertilizers, and planting none but clean "seed." If the seed is not known to be clean it should be disinfected with corrosive sublimate solution. This later process added 50 per cent to our yield of marketable potatoes on one plot in 1894. (Pages 100–102.)**

## II. RELATION OF WEATHER OF 1894 TO PLANT DISEASES.

The occurrence of fungus diseases upon plants is largely controlled by the weather. The late blight and rot of potatoes for example is especially destructive only during those periods when the conditions of temperature and moisture are combined in a certain way. The amount of damage to a plant from the slower acting fungus diseases (e. g. early blight of potatoes) and also from insect troubles, depends very largely upon the vigor of the plant, and this in turn is controlled by the conditions of weather. Hence, in any study of plant diseases and their remedies meteorological problems are of importance. This was especially true in 1894. Leaving a fuller statement of these conditions to the Annual Report we preface this bulletin with the main facts.

The spring was exceptionally early so that up to the middle of May vegetation was fully a week in advance of its usual development. During the last ten days of May and the first week of June cold rains fell almost continually. Following this during June, July and August was a period of prolonged drouth, broken only by occasional and inadequate showers.

As a result, most fungus diseases were less troublesome than usual. This was especially true of the potato blights and rot, our plots remaining practically free from these diseases. There was also less loss from apple and pear scab than is common. In consequence many who sprayed their crops, especially potatoes, expecting the usual heavy losses from these fungus diseases, felt that in the absence of this loss their efforts were wasted. We expected the same ourselves until late in the summer when we found that the dry weather, while saving our crops from fungus diseases, was bringing upon them an unusual horde of insect pests, These peculiar conditions offered an opportunity, rare in Vermont, of observing the effects of Bordeaux mixture upon these insects. The results as discussed in the following pages show that the use of Bordeaux mixture in spraying our orchards and potato fields in a dry season like 1894, while not giving so striking gains as it has in wetter years, is nevertheless profitable.

## III. APPLE AND PEAR SCAB.

### WHY DO APPLES OR PEARS SCAB AND CRACK?

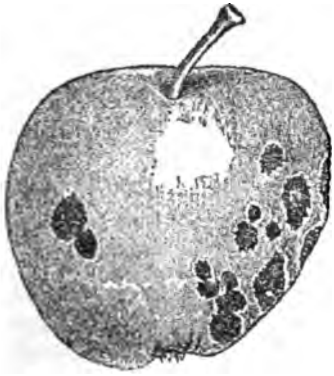

Fig. 1. A Scabby Apple.*

There are several fungus diseases which attack apples and pears in Vermont. The one which causes by far the greatest loss to fruit growers is that known as the *scab* or *black spot*. This disease is much worse on some varieties than upon others. Among apples the Fameuse is most subject to the scab. Figure 1 shows a scabby apple and illustrates the familiar fact that as a scab spot forms upon the side of the apple it checks the growth of that portion, causing the distortion of the fruit, and later, in bad cases, causing it to crack. A similar disease attacks pears, especially the Flemish Beauty, causing them to scab and crack even worse than any apple.

Examination of a scabby apple or pear shows that the scab spots are caused by a mould-like fungus growth. This fungus develops at first just underneath the thin outer skin of the fruit, but as it grows it soon bursts through this outer cuticle and appears as a greenish-black mould spot. As it first appears, and later when the weather is favorably moist, each spot consists of a velvety patch of greenish-black fungus growth. Seen under the microscope this velvety growth consists of tiny stems, each rising from a common mass of root-like filaments which sap the juices of the fruit, and bearing at its outer end an egg-shaped seed-body or spore. Such a

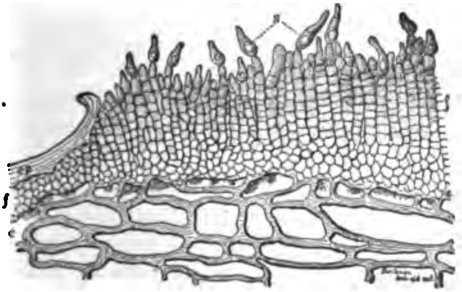

Fig. 2. The fungus of apple scab. (magnified.) The root-like filaments shown at *f* and the spores at *s*.

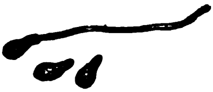

Fig. 3. Spores of fungus of apple-scab. One germinating.

* Figures 1, 2 and 3 were kindly loaned by Professor F. Lamson-Scribner. Fig. 4 is from Professor L. H. Bailey.

spot much magnified is shown in Figure 2. These seed-like spores are easily detached when ripe and carried by the wind to the neighboring healthy fruits or leaves where they germinate (see Figure 3) and start new scab-spots.

The most conspicuous scab-spots are found upon the fruit, but the fungus begins its growth upon the young leaves and twigs even before the fruit blossoms open in May. Wherever the fungus grows,—whether upon fruit, leaf or twig,—it draws its nourishment from the underlying tissues and thus saps their life. Examination of the leaves of any scabby apple or pear tree in June, will show the great damage that these parts are suffering, the diseased leaves being spotted with the fungus growth (see Figure 4) and soon becoming curled, deformed and sickly. In exceptionally bad cases a tree may be nearly or quite defoliated. When we realize the importance of healthy leaves for the development of fruit we are prepared to believe that the scabbing of the fruit really represents but one-half of the damage to our orchards from this fungus enemy.

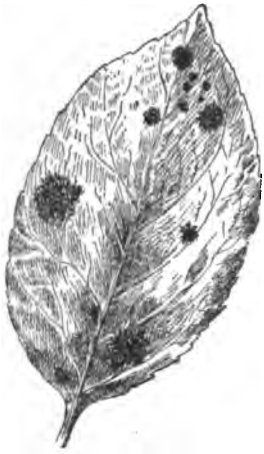

Fig. 4. Apple-scab spots on a leaf.

### REMEDIES FOR APPLE AND PEAR SCAB.

These facts concerning the cause of the disease being understood, we are prepared to combat it intelligently. The remedy consists simply in spraying the trees at intervals during spring and early summer with some fungicidal preparation which will destroy the spores of the fungus. Bordeaux mixture has proved to be the best of the many fungicides tested during the last five years. Three or four applications of this during May and June, especially if the surface of the trees is cleansed with a blue vitriol wash in April, will, in an ordinary season, keep even Fameuse apples and Flemish Beauty pears free from scabs or cracks. The value of this method of treatment was shown several years ago. It has been mentioned from time to time in our reports since 1890. Vermont orchardists have been slow, however, to test for themselves the value of spraying either against insect or fungus pests. In New York, for example, this is becoming the general practice, while in Vermont it is the exception to spray orchards. The explanation is simple. On most Vermont farms the orchard is secondary to other interests, especially to the dairy. The average farmer has his time so fully occupied with other duties that he is loth to undertake a new one until he is convinced that it will bring a sure reward. Moreover, Vermont as a State has climatic conditions which are quite different from those of the more southern and western states, and many of our best orchardists, realizing this, have been slow to adopt practices found successful in distant localities. Led by these considerations we planned to make another thorough test of the value of spraying apples and pears in 1894.

### RESULTS OF SPRAYING APPLES AND PEARS IN 1894.*

In order to give the results of the work as much practical value as possible the experiments were made in South Hero, in Grand Isle County, one of the finest orchard sections of the State. After visiting a large number of orchards, the one on the Phelps farm † was selected as best suited to the work. Our thanks are due Messrs. T. L. Kinney, Stephen Gordon and L. B. Phelps, for valuable advise and assistance in selecting the orchard and conducting the experiments. This orchard contains 60 acres of the standard varieties of fruits grown on Grand Isle, mostly apples in bearing, and has remarkably uniform soil conditions. The trees of the main portion of the orchard are about 25 years old. All the trees were sprayed in one row extending through the heart of this portion of the orchard, and in addition a number of scattering trees of certain varieties of apples and of Flemish Beauty pears. These scattering trees were selected, following the advise of the above named orchardists, from those varieties especially subject to scab. In another portion of the orchard were two rows of young Fameuse trees, just in good bearing. All the trees in one row of these were sprayed, the other row being left as a check. Altogether about 80 trees were under observation in the experiment, 40 being sprayed and 40 unsprayed.

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* Mr. A. G. Gulley, then horticulturist to this Station, assisted in planning and conducting the orchard experiments.

† Now owned by Miss Lydia M. Root.

### TABULAR SUMMARY OF THE SPRAYINGS AND WEATHER.

| *No. and date of spraying.* | *Mixture used.* | *What trees were sprayed.* | *Condition of trees.* | * *Meteorological conditions at time of and following the application.* | |
|---|---|---|---|---|---|
| | | | | Rain-fall. | Temp'ture. |
| 1st application, Apr. 23 | Bordeaux. | All trees included in the experiment. | Leaf buds swollen. | Only trace during next 10 days. | Warm for time of year |
| 2d application, May 4 | Bordeaux and Paris green. | All trees included in the experiment. | Leaves expanded. | .85 inch May 5–7.<br>.33 inch May 18–19. | Cool for time of year |
| 3d application, May 21 | Bordeaux and Paris green. | All but one Fameuse tree. | Last blossoms just falling. | .77 inch May 23–5.<br>1.41 inch May 28–31. | Cold for time of year |
| 4th application, June 2 | Bordeaux and Paris green. | All trees included in the experiment. | Fruit size of marbles. | .63 inch June 1–5. | Cool until about June 8 |
| 5th application, June 16. | Bordeaux. | Only two-thirds of the trees.† | | .67 inch June 27. | Normal for this season. |
| 6th application, July 3 | Bordeaux. | Only one-fifth of the trees.‡ | | | |
| 7th application, July 26. | Bordeaux. | 3 Fameuse trees. | | | |

Scab spots were found in abundance on both leaves and fruit of the unsprayed trees as early as June 1st, but none could be found on the sprayed trees.

This difference became still more marked as the summer advanced, the scab spots enlarging and new ones developing on the unsprayed trees, while the sprayed trees remained practically free from disease.

A glance at the above table shows that while some of the trees were given only 4 applications, others were sprayed 5, 6 and even 7 times. Examinations made during the summer and at time of harvest failed to show any advantage from the extra applications.

---

* Records made at Burlington but practically applicable to South Hero.

† Including all varieties under test.

‡ Including only varities most subject to scab, viz.: Fameuse and Winter Strawberry apples, and Flemish Beauty pear.

Examinations of the trees in mid-summer showed that the sprayed trees would make a profitable return for this extra care. In order to have visible proof of this fact for the State and Inter-State fair exhibits in September, 200 apples were picked from a sprayed, and the same number from an adjoining unsprayed tree of the same variety. In each case pains were taken to select trees standing close together, of the same age and equally loaded with fruit. The fruit was taken in all cases from the east side of the tree, picking *all* the fruit within reach from the ground. In this way samples were secured which represented fairly the relative conditions of sprayed and unsprayed trees of each of the following varieties: Flemish Beauty pear (sprayed tree had 4 applications), Fameuse apple (4 applications), Winter Strawberry and Yellow Bellflower apples (5 applications each). The fruit from each tree was then sorted by Mr. T. L. Kinney, one of the most expert judges of fruit in the State, into first, second and third classes on the regular market basis.

The results were as follows:

| | *1st class.* | *2d class.* | *3d class.* |
|---|---|---|---|
| Flemish Beauty Pear, sprayed, | 94 per cent. | 6 per cent. | 0 per cent. |
| “ “ “ not sprayed, | 55 “ | 43 “ | 2 “ |
| Winter Strawberry Apple, sprayed, | 65 “ | 24 “ | 11 “ |
| “ “ “ not sprayed, | 31 “ | 45 “ | 24 “ |
| Fameuse Apple, sprayed, | 46 “ | 28 “ | 26 “ |
| “ “ not sprayed, | 27 “ | 29 “ | 44 “ |
| Yellow Bellflower Apple, sprayed, | 47 “ | 42 “ | 11 “ |
| “ “ “ not “ | 39 “ | 38 “ | 28 “ |

The condition of the fruit from the sprayed and unsprayed Flemish Beauty pear trees is shown in Figures 8 and 9 which are from photographs of this fruit as exhibited at the State fair at White River Junction and at the Inter-State fair at Burlington.

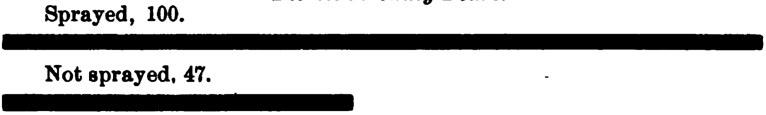
The actual profit from spraying was even greater than might appear from a first glance at the above figures. The market values of the No. 1 apples as sorted were just twice those of the No. 2, while the No 3, or "cider" apples were unsalable.

In the case of the pears, the difference becomes even greater, since the first class fruit from the sprayed tree was valued by one buyer as worth twice as much as that graded as first class from the unsprayed tree. Another buyer valued it as worth one and one-half times as much. The seconds of the pears are again worth only one-half as much as the first class fruit.

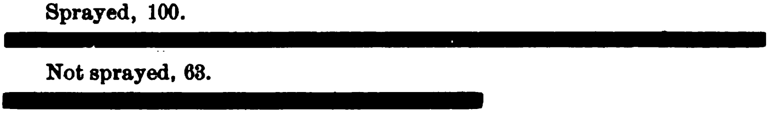
Moreover, the fruit from the sprayed trees averaged larger than that from the unsprayed trees.

Taking these elements into consideration and calculating the market values of the sprayed and unsprayed fruit, they become as follows :

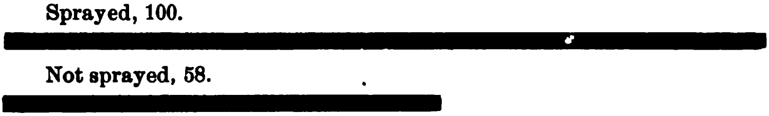
*Flemish Beauty Pears.*



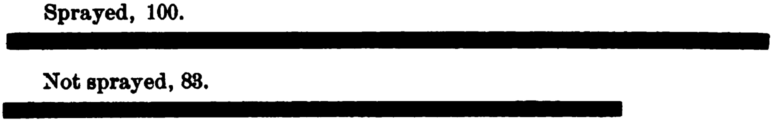
*Winter Strawberry Apples.*



*Fameuse Apples.*



*Yellow Bellflower Apples.*



The fruit on the remaining trees was picked and sorted in the same way as soon as mature. The condition of the fruit on the entire pear trees showed even greater gains from the spraying than did the above samples taken from the lower branches. With the apples, however, owing to the dry weather, the fruit of the upper branches of even the unsprayed trees was exceptionally fair and the gains from spraying were therefore less marked. The following are the results from the more important varieties :

| *Variety.* | *Relative Values of the Fruit.* | | *Gain from Spraying.* |
|---|---|---|---|
| | Sprayed Tree. | Unsprayed Tree. | |
| Flemish Beauty Pear | 100 | 46 | 117 per cent. |
| Fameuse Apple | 100 | 79 | 27 “ |
| Yellow Bellflower Apple | 100 | 81 | 24 “ |
| R. I. Greening Apple | 100 | 82 | 23 “ |

Another decided benefit from the spraying, which is not shown in the above estimate, was in the improved keeping quality of the sprayed fruit. Two barrels were filled with No. 1 Flemish Beauty pears, one with fruit from a sprayed tree, the other with fruit from an unsprayed tree. These barrels were placed side by side in a cool cellar. The unsprayed fruit soon softened and began to decay, while the sprayed fruit kept well, until fully three weeks after the last of the unsprayed fruit had decayed.

The amount of the gain from spraying was of course wholly dependent on the amount of the disease present. Owing to the remarkably dry weather there was, as already noted, less scab than usual upon any of the fruit. The Bordeaux mixture preserved the sprayed fruit almost perfectly free from scab. In order to determine the results in this regard more exactly, the entire crop of fruit from one sprayed and a corresponding unsprayed tree of each variety was examined with the following results :

TABLE SHOWING EFFECTS OF BORDEAUX MIXTURE IN PREVENTING THE SCAB SPOTS ON THE FRUIT.

| *Variety.* | *No. of Apples or Pears.* | | *Corresponding Per Cent.* | |
|---|---|---|---|---|
| | Scabby | Smooth | *Scabby.* | *Smooth.* |
| Flemish Beauty Pears not sprayed | 543 | 0 | 100 per cent. | 0 per cent. |
| “ “ “ sprayed | 5 | 560 | 1 “ “ | 99 “ “ |
| Fameuse Apples not sprayed | 1722 | 916 | 65 per cent. | 35 per cent. |
| “ “ sprayed | 278 | 2549 | 10 “ “ | 90 “ “ |
| Yellow Bellflower Apples not sprayed | 559 | 248 | 69 per cent. | 31 per cent. |
| “ “ “ sprayed | 16 | 757 | 2 “ “ | 98 “ “ |
| R. I. Greening Apples not sprayed | 90 | 286 | 27 per cent. | 73 per cent. |
| “ “ “ sprayed | 1 | 470 | .5 “ “ | 99.5 “ “ |
| Winter Strawberry Apples not sprayed | 739 | 174 | 80 per cent. | 20 per cent. |
| “ “ “ sprayed | 14 | 1373 | 1 “ “ | 99 “ “ |

The following statements from Mr. T. L. Kinney and Mr. L. B. Phelps express the judgment of two practical orchardists who watched the experiment carefully and critically and who assisted in harvesting and sorting the fruit. Mr. Phelps is the occupant of the farm where the work was conducted, while Mr. Kinney owns an adjoining orchard and is recognized as one of the most able and successful fruit growers of the State.

I watched the test of Bordeaux mixture for prevention of apple scab in the Phelps orchard from its beginning till its close with great interest. When asked my opinion about choice of orchard in which to conduct the experiment I advised this orchard as better fitted for a fair test than any other I knew on account of the varieties of fruit, the arrangement of the trees in uniform rows and the liability to scab. As every tree in the orchard was in bearing it afforded a very good opportunity for the experiment. The trees which were to be sprayed and those to be left unsprayed for comparison were carefully selected and properly labelled in the spring, and the age of trees, conditions of soil, fullness of blossoming and setting of fruit were in all ways equal in sprayed or unsprayed trees so that a fair trial of the mixture was insured. I had taken a deep interest in the success or failure of the experiment during the whole season, but was especially interested as the time for harvesting the fruit arrived. I witnessed the gathering of the fruit and upon invitation I did the sorting, grading it into 1st class, 2d class and 3d class ( or "ciders") on a strictly market basis. In the sprayed fruit of some varieties there was no scab at all, and in none of the sprayed fruit was there sufficient scab to appreciably affect its market value, while on the unsprayed fruit in every case the scab was abundant and very injurious. I have considered it a necessity for some years past to spray my orchard with Paris greenor London purple against insect injuries. I am now convinced that spraying with Bordeaux mixture against fungus troubles is just as important, in fact a practical necessity. Since the Paris green or London purple can be added to the Bordeaux mixture and all applied at one operation but little is added to the time and labor of spraying.

T. L. KINNEY.

The sprayed and unsprayed trees from which samples were taken in these experiments are of uniform size and thrift, and the test was in all ways a fair one. I helped in selecting the trees, in doing the spraying and in harvesting the fruit. Fameuse apples and Flemish Beauty pears are the worst varieties I have for scabbing. Where sprayed with Bordeaux mixture these varieties as well as others were practically free from scab spots or cracks, while the fruit from the unsprayed trees alongside was badly diseased as usual. I feel satisfied therefore that this Bordeaux mixture, properly applied, is a practical remedy for apple and pear scab.

L. B. PHELPS.

The results from spraying this orchard may be briefly summarized as follows:

*Flemish Beauty Pears: The amount of scabby fruit was reduced from 100 per cent. on the unsprayed trees to less than 1 per cent. on the sprayed tree; the amount of No. 1 fruit was increased from 55 per cent. on the unsprayed tree to 99 per cent. on the sprayed tree; the market value of*

SHOWING AVERAGE CONDITION OF FRUIT FROM SPRAYED AND UNSPRAYED TREES. (See details on page 87.)

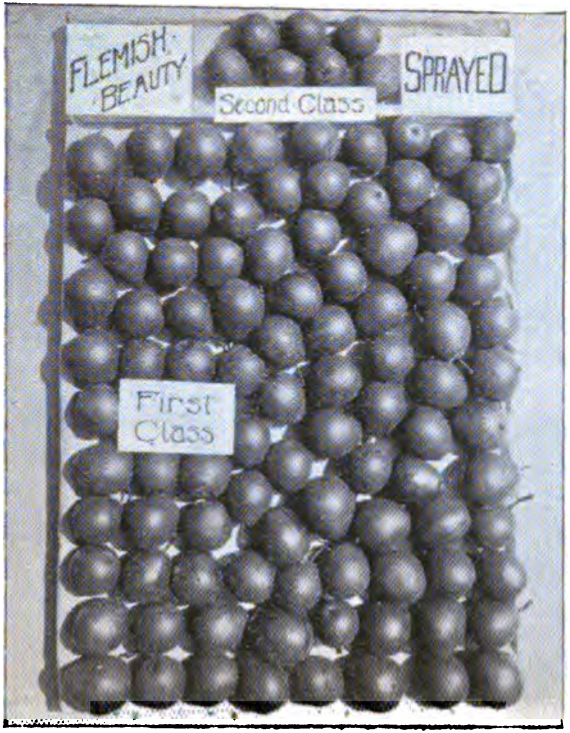


Figure 8. One hundred Flemish Beauty pears from sprayed tree showing relative amounts of 1st and 2d class fruit.

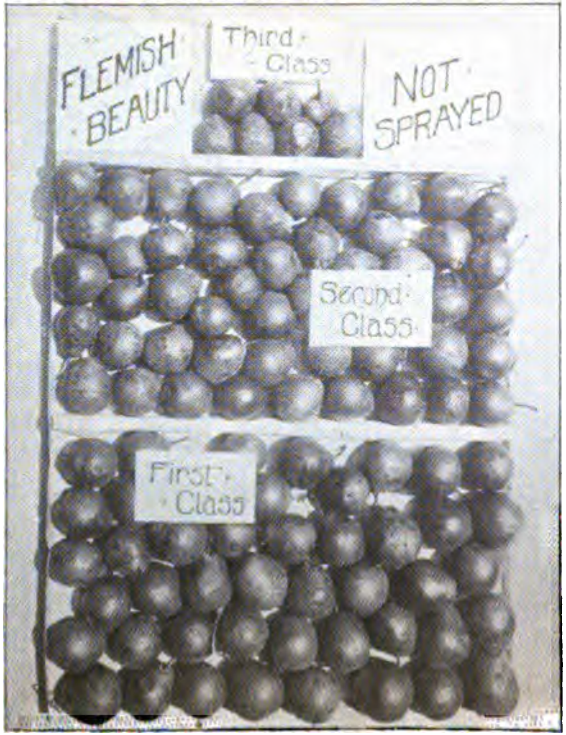


Figure 9. One hundred Flemish Beauty pears from adjoining unsprayed tree showing relative amounts of 1st, 2d and 3d class fruit.

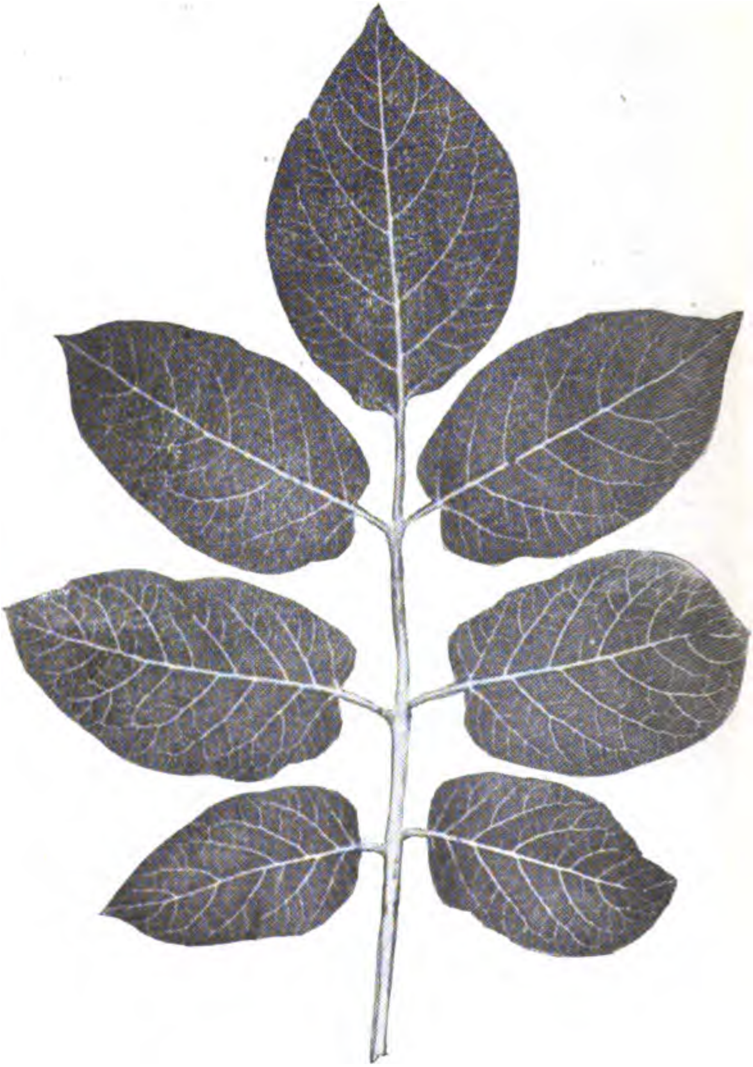


Figure 10.—A perfect Potato Leaf, sprayed with Bordeaux mixture. (See page 95.)

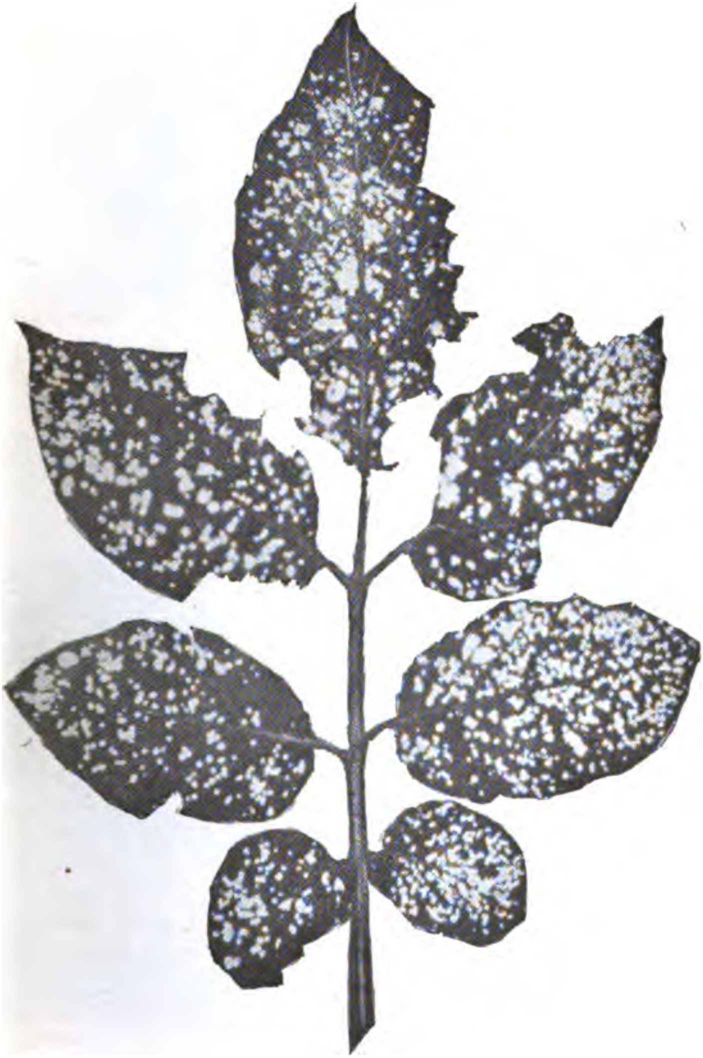


Figure 11.—A Potato Leaf showing holes eaten by Flea-beetles. (See page 95.)

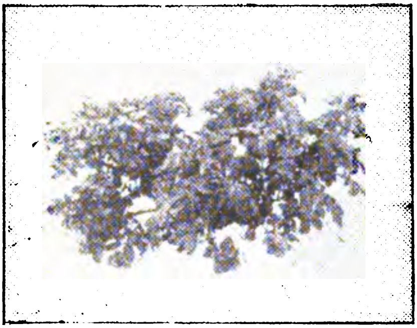


Fig. 12. A healthy hill of potatoes. Sprayed with Bordeaux Mixture.

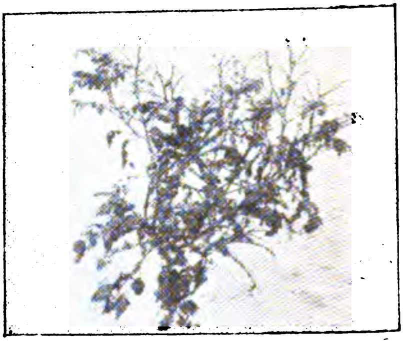
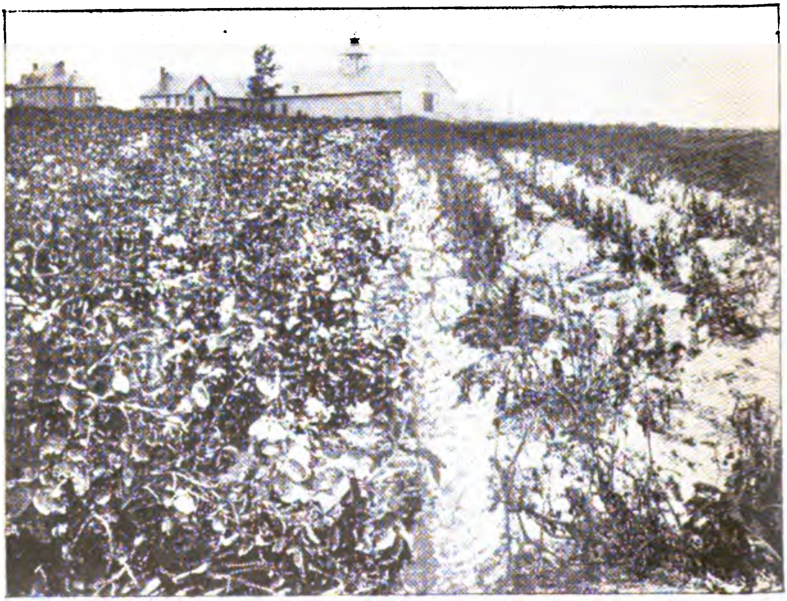


Fig. 13. Not sprayed. The upper leaves cut off by Grasshoppers



SPRAYED. NOT SPRAYED.

Figure 14. From photograph of Station potato plots made Aug. 31. Showing beneficial effects of Bordeaux mixture chiefly from checking the Grasshoppers. (See page 97.)

*the crop was increased in the ratio of from 46 to 100, or a gain of 117 per cent.*

*Fameuse Apples: The amount of scabby fruit was reduced from 65 per cent. on the unsprayed tree to 10 per cent. on the sprayed tree; the amount of No 1 fruit was increased from 43 per cent on the unsprayed tree to 60 per cent. on the sprayed tree; the value of the crop increased in the ratio of from 58 to 100 or 72 per cent. on the lower limbs of the tree, and in the ratio of 79 to 100 or 27 per cent. on the entire tree.*

*Other varieties subject to scab (Yellow Bellflower, R. I. Greening): The amount of scabby fruit was reduced from an average of about 50 per cent. on the unsprayed trees to about 4 per cent. on the sprayed trees; the amount of No. 1 fruit increased from about 55 per cent. on the unsprayed trees to 80 per cent. on the sprayed; and the value of the crop increased in the ratio of 81 to 100 or 23 per cent.*

*Four applications* of the mixture gave as good results as six or even seven. In seasons when the rainfall is more abundant, the disease is worse that it was last summer and the gains are proportionately greater. We therefore feel justified in urging the more general use of Bordeaux mixture as well as Paris green in spraying orchards. Following are brief directions for doing this.

### BRIEF DIRECTIONS FOR SPRAYING ORCHARDS.

1. *Apparatus.*—Some kind of force pump is necessary for spraying trees. If the Bordeaux mixture is to be used the pump must have brass working parts. Good spray pumps of varying capacities and costs are now manufactured by a large number of firms and are advertised in all agricultural journals. For small orchards or those on a side hill where it is impossible to drive, a small "hand" or "bucket" pump may be used, list prices $3.00 to $9.00. For larger orchards and those where a wagon can be driven, a larger "barrel" pump is better, list prices $8.00 to $16.00. The most important features of the outfit are good spray nozzles and some means of elevating these into the tree. The only nozzles we can recommend for use with the Bordeaux mixture are the Vermorel and the McGowan.* In spraying large trees with either of these it is necessary to

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*The Vermorel is not patented and is sold in some form by all pump manufacturers. The McGowan is patented and can be obtained from John McGowan, Ithaca, N. Y. The McGowan throws a good fan-shaped spray ten feet or more from the nozzle. The Vermorel throws a finer cone-shaped spray but for only about six feet. If only one nozzle is used we prefer the McGowan for orchard work. If the pump carries two discharge hose (as most barrel pumps do) a convenient arrangement is to use a Vermorel on one hose for the lower branches and a McGowan on the other for the upper portions of the tree.

elevate the nozzle into the tree in some manner. There are three good ways of doing this.

First,—where light hose (¼ or ⅜ inch) is used the nozzle can be tied to the end of a light pole (e. g. stiff bamboo fish pole) 8 or 10 feet long.

Second,—a device called the "bamboo-extension" is supplied by most pump firms; it consists of a ⅜ inch brass pipe inside a bamboo pole; the lower end couples on to the discharge hose of the pump while the nozzle is attached to the upper end.

Third,—a similar device, cheaper but not quite so convenient, can be made by coupling 8 or 10 feet of ⅜ inch iron gas pipe to the hose and attaching the nozzle to the upper end of this.

2. *Paris Green for the Codlin Moth* * (or apple core worm) and for the leaf-eating insects (Canker-worms, tent-caterpillars, leaf-rollers, etc.). All varieties of apples and pears are more or less attacked by these and similar insects. A large part of these injuries can be prevented by spraying the trees with Paris green. (1 pound of Paris green in 200 gallons of water or of Bordeaux mixture if this is to be used.)

The entire orchard should be sprayed once, and better twice, making the first application as soon as the petals have fallen, and a second ten days or two weeks later.

3 *Bordeaux Mixture for the Scab.*—All varieties of apples and pears which are liable to scab should be sprayed with Bordeaux mixture. When the Bordeaux mixture is prepared Paris green can be added, making this "Bordeaux-Paris green mixture" a combined fungicide and insecticide. The treatment for scab should be as follows:

First application, *before the leaf buds burst*, spray the limbs and trunk thoroughly with a solution of 3 lbs. of copper sulphate in 1 barrel (45 gallons) of water. (If the leaves are beginning to appear before this application is made, use the Bordeaux mixture instead, as the simple solution of copper sulphate would kill the leaves.)

Second application, *as soon as leaves are out*, and before the blossoms open, spray with the Bordeaux-Paris green mixture. (See formula below.)

Third application, *as soon as blossoms have fallen*, Bordeaux-Paris green mixture.

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*The apple maggot or "Railroad worm" is becoming a serious pest in many orchards of the State. This should not be confused with the Codlin moth, as the two require different remedies. Paris green does not destroy the apple maggot. Probably the best and simplest remedy lies in keeping a sufficient number of hogs in the orchard to eat all wind-falls as fast as they drop. Dr. T. H. Hoskins, of Newport, recommends spraying with Bordeaux mixture as a remedy. It is to be hoped that this will prove effectual, but it needs further confirmation.

For fuller account of this insect see Professor Perkins' article, page 130 of the last (7th) Report of this Station.

Fourth application. *about 2 weeks after third,* Bordeaux mixture.

A fifth application may be made in July if rainy weather necessitates.

4. *To make Bordeaux mixture,* dissolve 6 pounds of copper sulphate in water and strain it through a cheese cloth into the pump barrel or other vessel used in spraying). Slack the necessary amount of lime (4 to 5 pounds), add to it water enough to make a thin whitewash, then strain this into the barrel. Fill the barrel with water, (making 45 to 50 gallons altogether) and stir thoroughly. Add Paris green at the rate of 1 pound to 200 gallons (¼ pound per barrel of the mixture).

*Suggestions.* Copper sulphate solution alone will kill the leaves. Lime is added to combine with the sulphuric acid and prevent this injurious action. To do this it must be fresh or stone lime, not air-slacked. Cases where Bordeaux mixture injures foliage are generally due to the use of poor or air-slacked or insufficient lime. Two-thirds of a pound or even less of good lime will fully neutralize a pound of copper sulphate. An excess of lime will, however, do no harm, so it is always safe to use an excess, e. g. equal weights of lime and copper sulphate. Chips, threads, lumps of unslacked lime, etc., in the mixture will clog the pump and nozzle. Use great care to keep barrel and mixture perfectly clean.

A good way to dissolve copper sulphate in cold water is to put it in a coarse sack and suspend this over night in the top of the vessel of water. The quickest way is to dissolve in boiling water in a brass kettle.

If one is using much Bordeaux mixture it saves time to dissolve up a large amount of copper sulphate, using exactly one pound per gallon of water. This can be kept indefinitely in a closed vessel and used as needed. Lime may be slacked and kept in the same way if covered with water. To avoid the trouble of weighing the lime, the mixture may be tested with ferrocyanide of potassium. To do this add about a proper amount of the lime white-wash, then after stirring pour in a few drops of a saturated solution of ferrocyanide of potassium (procured for a few cents from any druggist). If enough lime has been added this solution will not change color as it comes in contact with the mixture, otherwise it will immediately turn brick red. In this latter case more lime should be added and the test repeated until the ferrocyanide solution does not change. It is not certain that the mixture made in this way is as safe or effective as in the ordinary method where more lime is used.

## IV. RESULTS OF SPRAYING POTATOES IN 1894.

The average yields of our later potatoes were more than doubled during the years 1892–93, by two or three applications of Bordeaux mixture.* These enormous gains were chiefly due to the effect of the mixture in checking the late blight and rot.†

Three applications of this mixture upon earlier potatoes in 1893 increased the yield some 50 per cent.‡ These earlier potatoes did not suffer appreciably from the late blight and rot and the gain noted was chiefly due to effect of the mixture in preventing the early blight.* It was observed, however, that the Bordeaux mixture was further beneficial in that it checked the ravages of the insect known as the flea-beetle, which considerably injured the potatoes, especially the early varieties.

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* *1892.* White Stars, planted May 15, yield per A.: sprayed, 325 bu.; not sprayed, 100 bu.
*1893.* Burbanks, planted May 9, yield per A.: sprayed, 332 bu.; not sprayed, 219 bu.
Polaris, planted May 9, yield per A.: sprayed, 378 bu.; not sprayed 169 bu.
White Stars, planted May 20, yield per A.: sprayed, 400 bu.; not sprayed, 169 bu.
*Averages of the two years: sprayed, 359 bushels per A.; not sprayed, 164 bushels per A.*

† Caused by the fungus *Phytophthora infestans.*

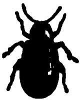

Fig. 5. The Flea-Beetle.

The severity of the potato diseases, blights and rot, depends very largely upon the weather. The weather was a little more favorable to these diseases in 1892 and 1893 than it averages, and the gains from spraying in those years were proportionally larger than usually may be expected. In sharp contrast with the moist seasons of 1892 and 1893, the summer of 1894 was one of most exceptional lack of rain-fall. The continuous drouth from June till September preserved our potato fields practically free from both the early† and the late blights. Of course under these conditions there were no such striking gains as in former years from the use of Bordeaux mixture. These peculiar conditions did give, however, an opportunity, rare in Vermont, for observing the effects of Bordeaux mixture upon insects. The warm dry weather made certain insects, notably flea-beetles and grasshoppers, unusually abundant upon our potato-plots. All portions of the field were kept poisoned with Paris green, applied either in water or with plaster, sufficiently to keep the Colorado potato beetle from doing serious damage. Neither the flea-beetles nor the grasshoppers were appreciably checked by this poison, however. Our observations of 1893 had led

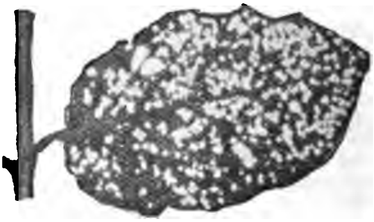

Fig. 6. Potato leaf eaten by Flea-beetles. (See also Figure 11.)

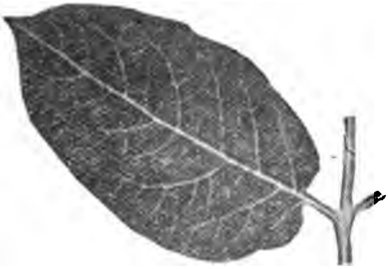

Fig. 7. Healthy potato leaf, sprayed with Bordeaux mixture. (See also Figure 10.)

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‡ Polaris potatoes planted April 29, 1893, yielded per acre; sprayed, 254 bushels; not sprayed, 170 bushels.

* Caused by the fungus *Macrosporium Solani*.

† As clearly marked a case of early or *Macrosporium* blight as we have ever seen swept off a piece of early potatoes in a neighboring field, but practically no trouble of this nature was observed in our own plots.

us to hope that the Bordeaux mixture would prove a more effectual remedy against the flea-beetle and experiments to test this were planned for 1894.

Under the peculiar conditions of 1894, we watched the results with keen interest. Our hopes were more than realized. The mixture proved an almost perfect remedy for the flea-beetles. So few of our potato-growers have learned to recognize this little pest that we insert, in Figure 5, an engraving showing one of the insects considerably magnified. Its actual length is about one-sixteenth of an inch as shown by the line at the left of the beetle. The name flea-beetle was given it because of its ability to jump to a considerable distance when disturbed. Owing to this agility and to its small size it is over-looked by all except careful observers, and the amount of damage actually done by it to potatoes in Vermont, is realized by but few. It operates by eating minute holes in the potato leaves. Figure 6 is from a photograph showing its work. Potato leaves thus riddled with holes shrivel and die in a very short time during the dry weather of mid-summer. As the leaves die thus, the appearance of the plant often resembles the blight, and we receive each summer many letters from potato-growers who have confused the injuries of these beetles with the blight. In more moist seasons leaves thus mutilated do become an especial prey to fungus attacks.

This insect is no new pest. The first notice of its injuries is by Harris,* who reports it as causing serious injury to potatoes in Lowell, Mass., in 1851, and states that its injuries were popularly associated with the potato blight. E. S. Carman, Editor of the "Rural New Yorker" in reporting the results of his famous potato contest in 1888, says:*

> "After the above date (June 3) all hope was lost of winning the contest. It was evident that the crop would be nearly a failure. The cause was discovered to be the flea-beetle. The first suggestion came from our foreman, who said that his own potato tops were dying, and that they were alive with fleas that were eating the leaves. 'There are so many,' said he, 'that you can hear the noise they make when disturbed as I pass along the rows.' The writer had noticed while sifting plaster and Paris green that these insects existed in unusual numbers, but it did not occur to him that they were the cause of the mischief. An examination of neighboring fields was made, and all were found to be injured more or less. Later, as the facts were published, accounts from many parts of the country were received showing that the pest was not confined to any limited section. Many who previously attributed the destruction of their potatoes to 'blight' found that the flea-beetle was really the culprit. We sprayed the vines with Buhach-water, hellebore, Gishurst compound and Paris green, but without the slightest helpful effect."

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* Insects Injurious to Vegetation, p. 128.

* The New Potato Culture, p. 17.

The same writer in an editorial in the "Rural New Yorker," January, 1895, says: "We have tried about everything to fight this pest but without much success."

In our plots in 1894, two broods of the beetle were observed. The first brood appeared early in June, and after doing considerable damage to early potatoes disappeared about June 12th. None of the plants had been sprayed previous to this. The next brood came out about July 20th, when the beetles appeared in countless numbers and soon riddled the leaves of the unprotected plants. All the leaves which were coated with the Bordeaux mixture were left practically untouched. The contrast between the sprayed and unsprayed rows soon became so striking as to arrest the attention of every visitor to the field. To determine the actual conditions more exactly, two leaves were taken from the side * of each hill of a sprayed row and of an adjoining unsprayed row, which had, however, been poisoned with Paris green. By actual count the average number of holes per leaflet from the unsprayed row was found to be 262, while from the sprayed row the average was 12. This brood worked actively for about two weeks, then began to disappear. Many of the unsprayed plants put out some new shoots and continued a sickly existence but never become vigorous. When the plots were dug the yields from the unsprayed rows of this plot averaged 56 lbs., 10¾ oz. while from the corresponding sprayed rows the yield averaged 68 lbs., 9 oz., showing a gain of over 20 per cent. Probably not all of this gain was due to checking the work of the flea-beetle. A small part of it was due to the similar action in keeping the grasshoppers from the plants as is explained later. Bordeaux mixture has moreover some beneficial action upon plants aside from any relation to fungi or insects. A portion of this increase should doubtless be attributed to this action. Doubtless also there were minor fungus troubles that escaped detection. Making due allowance for these, however, we feel that a large portion of the above gain must be attributed to the effect of the mixture upon the flea-beetles. This mixture did not act as a poison, for the beetles did not eat the leaves, it was simply offensive to them, serving as a deterrent.

Another portion of our field had been planted much later than the plots previously described. These plants were still in vigorous growth and so suffered less from the attack of the flea-beetles. None of these had as yet been sprayed. Expecting that the blight might soon appear a portion of this field was sprayed August 1st.

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*They were taken about midway between base and top in justice to the experiment since the lower (older) leaves had been somewhat eaten by the first brood and many of the upper (younger) leaves had developed since the spraying was done.

About this time the last of the hay crop was removed from the adjoining fields.* Thereupon the grasshoppers migrated in large numbers from this hay field and settled especially upon these younger potato-plants. Here again as with the flea-beetle the Paris green did not seem sufficient to check them. Probably this was because they did their most serious damage by eating the stems and the petioles of the leaves where but little poison was present. The appearance of the mutilated plants is shown in Figure 13. But the Bordeaux mixture seemed equally as offensive to them as it had to the flea-beetles. The result was that, before the last of August, the contrast between the sprayed and unsprayed rows of these later potatoes was almost as marked as it has been in seasons when the blight has swept over the field. The grasshoppers had cut off so many leaves that the plants were all dead upon the unsprayed rows, while the adjoining sprayed rows were comparatively thrifty. The appearance of the field on August 31 is shown in Figure 14. When dug these sprayed rows yielded 152 bushels per acre, while the unsprayed rows yielded only 118 bushels per acre.

Here again we cannot attribute all of the difference to the work of the grasshoppers, some little was due to the flea-beetles, some doubtless to unperceived fungus troubles, and some to the unexplained beneficial action of Bordeaux mixture. Careful observations in the field from day to day left no doubt in our minds, however, that the greater part of the difference was due to the action of the mixture as a deterrent against the grasshoppers.

With these additions to our experiments of former years in the use of Bordeaux mixture we feel justified in formulating the following practical conclusions:

*First. In seasons when the rainfall is normal during July and abundant during August, as it usually is in Vermont, potatoes suffer severely from fungus diseases, early potatoes from the early blight and late potatoes from the late blight and rot. These diseases can be controlled by the use of Bordeaux mixture and the yields increased thereby to a very profitable degree.*

*Second. In exceptionally dry seasons, like that of 1894, the loss from the fungus diseases is comparatively small. The use of the Bordeaux mixture in such seasons is rendered profitable by its repellant effect upon certain insects, notably flea-beetles, which are most troublesome during dry seasons. This mixture has some unexplained, beneficial effect upon plants in addition to its action upon fungi and insects.*

*Third. In view of these facts we feel more confident than ever before in urging the more general use of Bordeaux mixture by Vermont potato*

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* Purchased in July, hence the late cutting.

*growers, in dry seasons as well as wet ones, and on early potatoes as well as late ones.*

From experience at Burlington we would advise spraying as follows:

Upon very early potatoes the first application should be made the of June and two others should follow at intervals of two or three weeks.

Upon medium potatoes the first application may be delayed until from the first to the middle of July, after which it should be repeated twice at intervals of from ten days to three weeks, depending upon the amount of rainfall.

Upon late potatoes the spraying need not begin until the latter part of July or the first of August; it should then be repeated twice at intervals of ten days or two weeks, depending upon the weather.

Bordeaux mixture may be prepared following the directions on page 93. It can be safely used much more concentrated than this upon potatoes. If properly made there is no danger of its injuring the potato leaves. Add Paris green as needed for the Colorado potato beetles. Apply in any way so as to cover the surface of the leaves. This can be done most rapidly and economically with a force pump, the best form for small fields being the knapsack pump, and for larger fields a barrel force pump carried on a two-wheeled cart.* The cheaper forms of hand pump and even the common watering cans, or a pail and brush broom, are used by many with good success, but such methods are of course more wasteful of both time and mixture.

## V. OBSERVATIONS UPON THE DATE OF PLANTING POTATOES.

Any practical study of the diseases of the potato in Vermont must include a consideration of the date of planting, and consequently of the maturity of crop. As a result of observations and experiments extending through the years of 1890–93, the conclusion was published in our last Report that when one is working merely for the largest crop with the least possible work in protecting it from insects and diseases, he will do best to use a vigorous variety of medium or late potatoes, and delay the planting until about May 10th to 20th. The reason for this is obvious when the usual conditions of rainfall are considered. Potatoes planted in the last of April will form their tubers during the period extending from the last of June to the first of August, the exact time varying with the variety, that is, whether it is an early or late one. Now, potato tubers contain about 80 per cent. water, the remainder is starch, and in the manufacture of this starch a large additional amount of water is consumed. During the period of tuber formation the potato plant therefore needs its largest supply of water. As a matter of fact, however, the period from the last of June to the first of August is usually the driest portion of our summer. By planting potatoes the last of April, therefore, we force them to form tubers when the water supply is least, and as a result we rarely get a full crop. In fact, if there are serious attacks of insects or of fungus diseases during this period, the earlier planted potatoes die or "ripen permaturely," giving a small yield of imperfectly ripened potatoes. The only compensation is that these early potatoes, dying thus in the dry weather, largely escape danger from the late blight and rot. Before a remedy for this disease was known most successful potato growers preferred to plant early and thus be sure of the smaller yield, rather than to plant later and run the risk of serious loss from the blight and rot. By the use of Bordeaux mixture later potatoes may now be perfectly protected against disease during the warm, moist weather of August and early September. By planting May 10th to 20th, the later varieties form their tubers during this period, which is usually the most favorable of all the summer, and as a result very large yields become possible. For example, in 1893, Polaris potatoes planted April 29, under the best treatment of spraying, etc., yielded 295 bushels per acre; while Polaris potatoes taken from the same bin and planted May 9, with the same treatment, yielded 378 bushels per acre. White Stars, planted May 20, yielded 400 bushels per acre. The conclusion, therefore, based on the experiments of 1890–93, was that the later planting is the most profitable. In 1894, however, results were exactly reversed. Our plantings of the same varieties extended from April 29 to May 23. The largest yields came from the earliest planted, the smallest yields from the latest. Looking for the reasons, they are easily understood. To begin with, the first week of May was the warmest of the month. The early planted potatoes got rooted and started under favorable conditions. About May 20 cold, wet weather set in and lasted for two weeks. The later planted potatoes lay in the ground without starting during this time, and many of them rotted before or immediately after sprouting. Immediately following this in June a protracted drought began which continued into September with but slight and infrequent rainfalls. Of course, the late planted potatoes, starting under unfavorable conditions, never fully recovered, and they made a poor growth throughout the summer. When the attacks of the flea-beetles and grasshoppers came in July and August the plants which were mutilated by them very generally succumbed to the combination of insect attacks and dry weather. The early planted potatoes made sufficient growth in early summer to more fully shade the ground and developed sufficient root system to carry them more successfully through these disastrous conditions into September, when the welcome rains came. Where they were protected by Bordeaux mixture the majority of them lived until late fall. There was no hard frost in Burlington until November, and some of the more vigorous plants still held a good portion of their leaves green until this date. It is a remarkable record for potato vines in Vermont. Polaris potatoes, planted April 27, lived past the middle of October, nearly six months from planting till death, and White Stars planted on the same date lived into November, or over six months from date of planting. Usually these same varieties of potatoes when planted in April have died in August or by September first. Apparently, the peculiar weather conditions of May to July retarded their maturity and induced such a gradual formation of tubers that they persisted longer than usual. Probably, also, the entire absence of the early blight from the field during the summer conduced to the same result. The date of planting should, therefore, depend upon whether one is prepared to spray, and also upon the conditions of weather which are to be expected. In our judgement, the season of 1894 was such an exceptional one that the results should not lead to any modifications of our former advice, and that for the largest yield in Vermont medium or late planting, combined with spraying, should be practiced.

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*See illustration and description of a convenient form in Bulletin 40.

## VI. POTATO SCAB AND ITS PREVENTION.

With practical remedies for the potato beetles and other leaf eating insects and for the potato blights and rot, the most serious trouble left for the potato grower to contend with is the scab.

### THE CAUSE OF POTATO SCAB.

Attention has been called in former reports to the demonstration by Dr. Thaxter, then of the Connecticut Experiment Station, that potato scab is caused by a fungus growth, a sort of mould upon the tuber. These investigations indicate that this fungus is propagated (first) by germs or spores which may pass the winter upon the surface of tubers and so start the disease anew if such tubers are planted, or (second) by spores which may live over winter in the soil when once established there, or (third) by spores which are carried on cultivators, etc., from infected soil, or (fourth) by spores carried in stable manure. Prof. Hopkins, of the West Virginia Experiment Station, considers that the trouble in that section of the country is increased, if not originated, by the larvae of certain very minute insects inhabiting the scab spots. So far as he has worked out the matter of remedies for this insect trouble, they entirely coincide with the following for the scab fungus which were worked out largely by Prof. Bolley of the North Dakota Experiment Station.

### THE PREVENTION OF POTATO SCAB.

1. Select ground and manure that are as free from the germs as possible. To do this avoid ground that has borne a crop of scabby potatoes at any time for a number of years previously. Land that has lain in grass for several years is most likely to be clean. Avoid the use of fresh stable manure. Use thoroughly rotted manure. If possible, apply this manure on the crop the year before potatoes are to be planted. Use commercial fertilizers.

2. Plant nothing but clean seed potatoes. If there were no scabby potatoes whatever in the crop from which seed is to be taken, any of these potatoes may safely be planted. If, however, as is generally the case, a portion of the crop was scabby, it is not sufficient to select smooth tubers, for they will probably be contaminated with the germs from the scabby ones. If they are to be used they should first be disinfected with corrosive sublimate. Following are practical directions for so disinfecting them:

Purchase from a druggist two ounces of corrosive sublimate (bichloride of mercury.)* Empty this into two gallons of hot water in a wooden or earthen vessel, and allow it to stand over night. Place in a barrel, or wooden tub, thirteen gallons of water, then pour in the two gallon solution. Stir thoroughly to insure equality of solution before using. Select as fair seed potatoes as possible, rinse off the old dirt and immerse them in the solution one hour and thirty minutes. At the end of this time turn off the solution into another vessel. The solution may thus be used a number of times if wished. After drying, the potatoes may be cut and planted as usual.

The practical value of this method of disinfecting seed potatoes has been thoroughly tested and demonstrated. There is no doubt that where the seed is thus treated a clean crop is insured, *providing* the soil is clean also. Unfortunately much of the best potato lands in Vermont is already contaminated. But understanding the nature of the disease each potato grower who chooses can soon by continued observation of his own crops and the use of clean seed reduce the loss from this disease to a minimum.

In our experiments last summer we had a piece of *grass* land which had been in grass for at least fifteen years. Commercial fertilizers alone were used upon it. In planting it we divided it into four series of plots.

These were planted as follows.

1st series: Planted with smooth seed, no previous treatment.

2d series: Planted with smooth seed, disinfected with corrosive sublimate before planting.

3d series: Planted with scabby seed, no previous treatment.

4th series: Planted with scabby seed, disinfected before planting.

When the crop was harvested there was no marked difference as to scabbiness between the crops from the first and second series. Many potatoes from both were slightly scabby, but none sufficiently so to make them unsaleable. This would indicate that the germs of the disease were generally distributed throughout this soil though not abundant or virulent enough to do much harm.

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*This should cost but a few cents. The corrosive sublimate is an active poison and great care should be exercised in its use. The strength of the solution as here recommended is the same as that used by surgeons for disinfecting wounds, etc., and is not dangerous to anyone working with it, unless taken into the stomach. Care should be taken in properly disposing of the solution, and all treated potatoes should be planted or buried.

The contrast between the plots of the third and fourth series was very marked, as is apparent from the following summary.

*Table showing yields of tubers of marketable size, in ounces, and the condition of these as to scab.*

| Variety of Potato. | Condition of "seed." | Treatment of ' seed" before planting | Yields in Ounces. | | | 4. Condition of these marketable tubers. | |
|---|---|---|---|---|---|---|---|
| | | | 1. Total yield of tubers of marketable size. | 2. Unmarketable because of the scab. | 3. Total yield of marketable tubers. | Free from scab. | Slightly scabby. |
| Polaris | Scabby. | None. | 1,143 | 209 | *934* | 298 | 636 |
| Polaris | Scabby. | Disinfected. | 1,368 | 14 | *1,354* | 884 | 470 |
| Wh. Str. | Scabby. | None. | 1,307 | 306 | *1,001* | 501 | 500 |
| Wh. Str. | Scabby. | Disinfected. | 1,591 | None. | *1,591* | 1,310 | 281 |

As shown in column 2 of the yields there was practically no loss of saleable tubers from scab where the seed was disinfected, while there was an average loss of 21 per cent. where the seed was planted with no treatment. As further shown in column 1, there was a decided increase in total yield from the disinfected seed, amounting on the average to over 20 per cent. The total yields of marketable potatoes (column 3) was increased over 50 per cent. as a direct result of disinfecting the tubers.

Of course in such a case as this where all the seed potatoes were scabby the gain exceeds what would be obtained in ordinary practice, but it nevertheless emphasizes in a striking manner the practical value of disinfecting seed potatoes where the scab is troublesome. The process of disinfecting them involves but slight labor and an expense of but a few cents for corrosive sublimate.

This corrosive sublimate treatment is being tested and endorsed by the leading potato growers as well as the Experiment Stations throughout the country. It is past the experimental stage.

Let every potato grower who reads this give the corrosive sublimate treatment as well as the Bordeaux mixture a fair trial this summer.

1895.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 45.

MARCH, 1895.

# Analyses of Commercial Fertilizers.

I. STATEMENT REGARDING PUBLICATION OF ANALYSES. (Page 3.)
II. SCHEDULE OF TRADE VALUES. (Pages 4-5.)
III. ANALYSES OF LICENSED FERTILIZERS. (Pages 6-7.)
IV. OBSERVANCE OF THE FERTILIZER LAW. (Page 8.)

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Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 45, ANALYSES OF COMMERCIAL FERTILIZERS.

### BY J. L. HILLS AND B. O. WHITE.

## I. STATEMENT REGARDING PUBLICATION OF ANALYSES.

The Legislature of 1894 amended the act commonly known as the "Vermont Fertilizer Law," providing that "so much of the license fees collected under this act shall be paid by the State treasurer to the treasurer of said Station as the director of said Experiment Station may show by his bills has been expended in performing the duties required by this act, but in no case to exceed the amount of the license fees received by the treasurer under this act."

The State appropriation to the Station expired in 1890. Doubting whether any of the funds received from the National Treasury under the Hatch Act could be legally used for this police work we have been forced to use the money received from the sale of farm and dairy products in order to comply with the law.

Having now more funds for this purpose, it is the design of the Station to make more thorough inspection and earlier publication of results than has hitherto been possible. Several bulletins will be issued at short intervals giving analyses to date, together with a discussion of the meaning of the terms used to designate the valuable ingredients of fertilizers, their sources, uses, commercial and agricultural values, etc. These bulletins will be mailed as usual to the entire mailing list and to all applicants.

The present bulletin contains an analysis of a single sample of a leading brand of goods of each manufacturer selling in this State, excepting the Great Eastern Fertilizer Company and John S. Reese & Co. Analyses reported in subsequent bulletins will be made on composite samples, (mixture of equal portions of several samples taken from different parts of the State), and will include determinations of nitrogen from nitrates and from ammonia salts, and of chlorin.

All samples are taken by agents of the Station from the stocks of local dealers and represent therefore exactly what the purchaser is getting.

## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this State, in 1895, is the one agreed upon by the experiment stations of Massachusetts, Rhode Island, Connecticut, New Jersey and Vermont after a careful study of prices ruling in the large markets of New England and the Middle States:

### TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1894 AND 1895.

| | 1894.<br>cts. per lb. | 1895.<br>cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 19 | 18½ |
| " in nitrates | 14½ | 15 |
| Organic nitrogen in dried and fine ground fish, blood and meat and in high grade mixed fertilizers | 18½ | 16½ |
| " " in cotton seed meal, | 15 | 12 |
| " " in fine ground bone and tankage | 16½ | 16 |
| " " in fine medium " " | 15 | 14 |
| " " in medium " " | 12 | 11 |
| " " in coarse " " | 7 | 5 |
| " " in horn shavings, hair and coarse fish scrap | 7 | 5 |
| Phosphoric acid soluble in water | 6 | 6 |
| " " " in ammonium citrate* | 5½ | 5½ |
| " " " in fine ground fish, cotton seed meal, and wood ashes | 5 | 5 |
| " " in dry fine ground fish and in fine bone and tankage | 5½ | 5½ |
| " " in fine medium bone and tankage | 4½ | 4½ |
| " " in medium " " | 3 | 3 |
| " " in coarse " " | 2 | 2 |
| " " insoluble (in ammonium citrate) " " in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate (or chlorids) | 5¼ | 5¼ |
| Potash as muriate | 4½ | 4½ |

The above trade values are the average figures at which in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st, plus about 20 per cent, in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable retail price at the large markets of standard raw materials such as, Sulphate of Ammonia, Nitrate of Soda, Muriate of Potash, Sulphate of Potash, Dried Blood, Plain Superphosphate, Azotin, Dry Ground Fish, Ammonite, Cotton Seed Meal, Bone and Tankage, Ground South Carolina or Florida Rock.

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* Dissolved from 2 grams of the unground phosphate previously extracted with pure water by 100 c. c. neutral solution of Ammonium Citrate sp. gr. 1.09 in 30 minutes at 65 degrees C., with agitation once in five minutes. Commonly called "reverted," or "backgone" Phosphoric Acid.

## APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS.

The trade values are applied to the valuation of superphosphates and all mixed goods as follows:

The nitrogen is valued at 16½ cents per pound, it being assumed that it is from such materials as ammonia salts, nitrates, dried blood, ground fish or nitrogenous substances of equally good quality.

The insoluble phosphoric acid of mixed fertilizers is reckoned at 2 cents per pound.

The potash is valued at 4½ cents per pound, the price of that ingredient in kainite and muriate if there is sufficient chlorin in the fertilizer to unite with all the potash; if not, such as is not thus united is valued at 5¼ cents per pound, the price of that ingredient in high grade sulphate.

The valuation of a fertilizer is obtained by multiplying the percentage of the several ingredients by 20 (which gives the pounds per ton), and these products by the prices per pound.

As **these estimated values are not intended to represent the proper selling price of mixed goods at the point of consumption**, and in order to prevent any possible misapprehension as to their real meaning, the following explanations are offered:

1. These trade values represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, in their various forms, can now be purchased, for cash at retail in our large markets. They are based mostly upon the ton prices at which certain classes of goods are offered to actual consumers.

2. These trade values do not include the charges for transportation from the market to the consumer, for storage, mixing, commissions to agents and dealers, selling on long credit, bad debts, etc., etc.

3. They are the prices of nitrogen, phosphoric acid and potash, *ready for use by the farmer*, when these ingredients are purchased under the above named conditions, singly and not mixed. In ordinary superphosphates we find these three ingredients mixed, but this not a necessary condition of their use.

An illustration may serve to make clear the above statements: A farmer wishes a ton of fertilizer similar to the well-known brands sold in this State. If he purchases for cash in New York or Boston, one hundred (100) pounds of muriate of potash, fifty (50) pounds of sulphate of ammonia, fifty (50) pounds of nitrate of soda and fifteen hundred and fifty (1550) pounds of dissolved South Carolina rock, known in the trade as "acid phosphate," and mixes these ingredients together, he will have a complete fertilizer, not essentially different from many standard brands of ammoniated superphosphates. The cost of the ton after mixing (if the farmer prefers to mix the ingredients) will be made up as follows:

(*a*) Cost of the materials in the markets.
(*b*) Cost of transportation.
(*c*) Cost of mixing.

The first element entering into the total cost, is the only one included in the "valuation." If there is added to this one element, not only the charges for transportation and mixing, but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary superphosphates, when delivered at or near the place of consumption.

4. The station valuations stand in no direct or necessary relation to the comparative profits which may be derived from the use of various fertilizers by individual farmers. These values have an almost purely commercial significance, and are not designed to point out to a farmer whether he shall use potash, which is comparatively a cheap ingredient, or nitrogen, which is comparatively costly.

For further information concerning fertilizer analyses and for an explanation of the meaning of the terms employed, the reader is referred to the previous reports and bulletins of the Station, and to bulletins which are to follow in the near future.

## III. LICENSED FERTLIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1259 | Hill and Drill Phosphate | Bowker Fertilizer Co., Boston, Mass. | W. C. Crippin, Fair Haven | 1259 |
| 1216 | XL Superphosphate of Lime | Bradley Fertilizer Co., Boston, Mass. | Randall & Crane, Greensboro | 1216 |
| 1276 | Bay State Fertilizer | Clark's Cove Guano Co., Boston, Mass. | W. B. D. Avery, Bradford | 1276 |
| 1231 | Corn and Grain Fertilizer | Cleveland Dryer Co., Cleveland, Ohio | J. P. Telfer, Barton | 1231 |
| 1239 | High Grade Ammo. Bone Superphos. | E. Frank Coe Co., New York, N. Y. | Brown & Skinner, Barton Landing | 1239 |
| 1248 | Ammoniated Corn Phosphate | Crocker Fert. and Chem. Co., Buffalo, N.Y. | W. R. Parker, Enosburgh Falls | 1248 |
| *1209 | Fertilizer | Cumberland Bone Phos. Co., Portland, Me. | W. H. Nye, Johnson | 1209 |
| 1258 | Superphosphate | Cumberland Bone Phos. Co., Portland, Me. | Donahue & Allen, Essex Junction | 1258 |
| 1252 | Success Fertilizer | Lister's Ag'l Chem. Works, Newark, N. J. | G. W. Pratt, Sheldon Junction | 1252 |
| 1213 | Soluble Pacific Guano | Pacific Guano Co., Boston, Mass. | Allston & Russell, East Hardwick | 1213 |
| 1260 | Sea Bird Ammoniated Guano | Powers, Gibbs & Co., Wilmington, N. C. | Edward Hayes, Wells | 1260 |
| 1229 | Phosphate | Quinnipiac Co., Boston, Mass. | S. M. Bartlett, West Burke | 1229 |
| 1286 | Farmer's Friend Superphosphate | Read Fertilizer Co., Syracuse, N. Y. | S. D. Whiting, Johnson | 1286 |
| 1278 | Fertilizer | Standard Fertilizer Co., Boston, Mass. | J. H. Bushnell, Williston | 1278 |
| 1224 | Americus Ammo. Bone Superphos. | Williams & Clark Co., New York, N. Y. | S. M. Bartlett, West Burke | 1224 |

*See foot-note to next page.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Found. | Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| 1259 | Bowker's Hill and Drill Phosphate | 2.55 | 2.47 | $ 8.42 | 7.52 | 2.24 | 2.92 | 12.68 | 12. | 9.76 | 9. | $12.66 | 2.14 | 2. | $1.93 | 1259 |
| 1216 | Bradley's X. L. Superphosphate... | 2.87 | 2.47 | 9.47 | 7.21 | 1.61 | 1.65 | 10.47 | 11. | 8.82 | 9. | 11.08 | 2.55 | 2. | 2.29 | 1216 |
| 1276 | Clark's Cove Bay State Fertilizer. | 2.28 | 1.85 | 7.52 | 7.22 | 1.59 | 1.19 | 10.00 | 10. | 8.81 | 8.5 | 10.89 | 2.70 | 2. | 2.43 | 1276 |
| 1231 | Cleveland Corn and Grain Fert... | 3.00 | 2.05 | 9.90 | 6.17 | 3.07 | 2.53 | 11.77 | 10.5 | 9.24 | 9.5 | 11.80 | 1.64 | 1. | 1.48 | 1231 |
| 1239 | Coe's High Grade Am. Bone Sup.. | 2.16 | 2. | 7.13 | 7.45 | 1.85 | 2.59 | 11.89 | 11. | 9.30 | 9. | 12.02 | 1.87 | 1.5 | 1.69 | 1239 |
| 1248 | Crocker's Ammo Corn Phosphate. | 2.38 | 2. | 7.85 | 6.80 | 3.00 | 1.63 | 11.43 | 11. | 9.80 | 10. | 12.11 | 1.74 | 1.85 | 1.57 | 1248 |
| *1209 | Cumberland Fertilizer............ | 1.30 | 1.03 | 4.29 | 6.03 | 1.66 | 1.40 | 9.09 | 10. | 7.69 | 8. | 9.63 | 2.59 | 2.6 | 2.33 | 1209 |
| 1258 | Cumberland Superphosphate ...... | 2.40 | 2.05 | 7.92 | 5.85 | 2.17 | 2.32 | 10.34 | 10. | 8.02 | 8. | 10.34 | 2.43 | 2. | 2.19 | 1258 |
| 1252 | Lister's Success Fertilizer.......... | 1.83 | 1.25 | 6.04 | 7.70 | 1.33 | 2.35 | 11.38 | | 9.03 | 9.5 | 11.64 | 2.11 | 2. | 1.90 | 1252 |
| 1213 | Pac. Guano Co.'s Sol. Pac. Guano. | 2.40 | 2.25 | 7.92 | 7.57 | 1.25 | 1.27 | 10.09 | 10.5 | 8.82 | 8.5 | 10.97 | 2.71 | 2. | 2.44 | 1213 |
| 1260 | Powers, Gibbs & Co.'s Sea Bd. Gu. | 1.81 | 1.23 | 5.97 | 7.75 | 1.86 | 1.97 | 11.58 | | 9.61 | 8. | 12.13 | 2.67 | 2. | 2.40 | 1260 |
| 1229 | Quinnipiac Phosphate ............ | 3.05 | 2.47 | 10.07 | 6.95 | 1.91 | 1.70 | 10.56 | 10. | 8.86 | 9. | 11.12 | 2.58 | 2.5 | 2.32 | 1229 |
| 1286 | Read's Farmer's Friend Superphos. | 2.31 | 2.05 | 7.62 | 6.61 | 2.32 | 0.77 | 9.70 | 10. | 8.93 | 9. | 10.79 | 2.18 | 2. | 1.96 | 1286 |
| 1278 | Standard Fertilizer................ | 2.29 | 2. | 7.56 | 5.73 | 2.41 | 2.16 | 10.30 | 10. | 8.14 | 8. | 10.38 | 2.36 | 2. | 2.12 | 1278 |
| 1224 | Williams&ClarkCo.'sAm.Amo.B.S | 2.82 | 2.47 | 9.31 | 6.37 | 2.82 | 1.76 | 10.95 | 10. | 9.19 | 9. | 11.44 | 2.55 | 2. | 2.29 | 1224 |

*Through a laboratory error two samples of Cumberland goods were analyzed.

## IV. OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law:

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1. | Pacific Guano Co. | Boston, Mass. |
| 2. | Quinnipiac Co. | Boston, Mass. |
| 3. | Bradley Fertilizer Co. | Boston, Mass. |
| 4. | Cleveland Dryer Co. | Cleveland, O. |
| 5. | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6. | Crocker Fertilizer and Chemical Co. | Buffalo, N. Y. |
| 7. | Standard Fertilizer Co. | Boston, Mass. |
| 8. | Cumberland Bone Phosphate Co. | Portland, Me. |
| 9. | Bowker Fertilizer Co. | Boston, Mass. |
| 10. | E. Frank Coe Co. | New York, N. Y. |
| 11. | Williams & Clark Co. | New York, N. Y. |
| 12. | Great Eastern Fertilizer Co. | Rutland, Vt. |
| 13, | Clarks Cove Guano Co. | Boston, Mass. |
| 14. | Powers, Gibbs & Co. | Wilmington, N. C. |
| 15. | John. S. Reese & Co. | Baltimore, Md. |
| 16. | Read Fertilizer Co. | Syracuse, N. Y. |

## 1895.

## VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 46.

## APRIL, 1895.

# Analyses of Commercial Fertilizers.

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1895.

# ORGANIZATION.

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 46. ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills and B. O. White.

## I. STATEMENT REGARDING COLLECTION OF SAMPLES.

During February and March, Messrs. J. B. Kidder, W. C. Perry and A. M. Vaughan, agents of this Station, visited seventy-two towns and villages in Vermont and drew 301 samples, representing 83 distinct brands of fertilizers. Only 53 brands were found last year and but 36 brands were analysed in 1893.

This rapid increase is partly due to an actual increase in the number of brands sold and partly to our inability to make a thorough search in previous years, owing to causes explained in Bulletin 45.

It is believed that one or more samples of nearly every brand of fertilizer sold in the State has been secured this spring. The Station desires that farmers, farmers' clubs and granges call its attention to brands of fertilizers on sale not included in this bulletin, either in the tables of analyses or the list of samples on hand. So far as is practicable goods thus reported will be sampled. It should be noted, however, that, as a rule, the Station will not sample or analyse

1. From stock of less than one ton.
2. From stock which has lain over from a former season.
3. From stock which has been improperly stored.

Bulletin 45, distributed to the State mailing list March 23d, contained an analysis of a single sample of a leading brand of goods of each manufacturer selling in this State, excepting the Great Eastern Fertilizer Co. and John S. Reese and Co. The present bulletin contains the analyses of composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the State) of 33 distinct brands, the output of eleven manufacturers. The composite sample certainly represents the average character of the goods more fairly than can the analysis of a single sample.

The 33 brands reported comprise all those of which three or more samples were found by the Station agents. There is reason to believe that fully nine-tenths of the trade in the State is confined to these brands.

The reader is referred to Bulletin 45 for schedule of trade values and their application to superphosphates and mixed goods. It should be particularly noted, however, that **these trade values do not represent the proper selling prices of mixed goods at the point of consumption,** but are the retail cash prices of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance.

# II. VERMONT FERTILIZER LAW.

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## No. 109.—AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.

*It is hereby enacted by the General Assembly of the State of Vermont:*

SECTION 1. Every lot or parcel of commercial fertilizers, or material used for manurial purposes, sold, offered or exposed for sale in the State of Vermont, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in a package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash, soluble in distilled water, and of phosphoric acid in available form soluble in distilled water, and reverted as well as the total phosphoric acid. In case of those fertilizers, which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients it accompanies.

SEC. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold, or offers it for sale within the State of Vermont, shall file with the director of the Vermont Agricultural Experiment Station a certified copy of the statement named in section one of this act, and shall also deposit with said director, at his request, a sealed jar, glass or bottle containing not less than one pound of the fertilizers, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 3. The manufacturer, importer or agent of any commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall, before the fertilizer is offered for sale, obtain a license from the State treasurer, countersigned by the director of the Vermont Agricultural Experiment Station, authorizing the sale of the same in the State, and shall securely affix to each barrel, bag or other package of fertilizer the word "licensed," with the number and date of the license. The manufacturer or importer obtaining such license shall pay to the State one hundred dollars for such license, and the license shall expire on the 31st day of December of the year for which it is issued. One license shall cover all brands manufactured by any one manufacturer, corporation or company.

SEC. 4. Manufacturers and importers of commercial fertilizers sold or offered for sale, the retail price of which is ten dollars or more per ton, shall, before such fertilizers are sold, offered or exposed for sale, file with the State treasurer a bond, with sureties residing within the State, satisfactory to said treasurer, in the sum of one thousand dollars, payable to the State and conditioned for the payment of forfeitures and costs imposed on such manufacturers and importers for violating the provisions of this act, and such bonds shall be renewed from time to time, as the State treasurer may require.

SEC. 5. The term "commercial fertilizer," as used in this act, shall be taken to mean compounds and manufactured substances containing, or represented as containing, two or more ingredients mentioned in section one of this act, but shall not apply to the separate ingredients used to manufacture the same, or to bone meal, land plaster, lime or any substance the product of nature which has not been compounded.

SEC. 6. No person shall sell, offer or expose for sale, in the State of Vermont, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or to go with every parcel or lot of the same.

SEC. 7. Any person selling, offering or exposing for sale, any commercial fertilizer, without the statement required by section one of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all of the provisions of the foregoing sections have not been fully complied with, shall forfeit fifty dollars for the first offense, and one hundred dollars for each subsequent offense. This section shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in this State.

SEC. 8. All manufacturers and importers of commercial fertilizers, or wholesale dealers in the same, shall, not later than February first, furnish the director of the Vermont Agricultural Experiment Station with a complete list of the brands and of agents selling, offering or exposing for sale, such fertilizers, and on the first of each succeeding month till May first such additional agents or dealers as in the mean time have been appointed.

SEC. 9. The director shall cause one analysis or more of each fertilizer or material used for manurial purposes, to be made annually and the result published monthly. Said director is hereby authorized, in person or by deputy, to take a sample not exceeding two pounds in weight for analysis from any lot or package of fertilizer, or any material used for manurial purposes, which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representatives, and shall be taken from a parcel or number of packages which shall not be less than five per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, carefully sealed, and a label placed on each stating the name of the brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing, and said label shall be signed by the director or his deputy and by the parties or party in interest, or their representatives present at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. The director of the Vermont Agricultural Experiment Station shall notify the State treasurer of all violations of this act, and the State treasurer shall commence a suit, in the name of the State, on the bond required to be filed by such manufacturer or importer, and prosecute the same to final judgment. It shall be the duty of the treasurer upon ascertaining any violations of this act, to forthwith notify the manufacturers and importers, in writing, and give them not less than thirty days thereafter, in which to comply with the requirements of this act. But there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material, if the same shall be found to be substantially equivalent to the statement of analysis made by the manufacturers or importers.

SEC. 10. The term importer, for all the purposes of this act, shall be taken to mean all who procure or sell fertilizers made in other States.

SEC. 11. Number one hundred and nineteen of the acts of 1882, and number eighty-nine of the acts of 1884, are hereby repealed.

SEC. 12. This act shall take effect January first, 1889.

Approved November 27, 1888.

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## No. 114.—AN ACT IN AMENDMENT OF AND IN ADDITION TO NO. 109 OF THE ACTS OF 1888, ENTITLED "AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS."

SECTION 1. Number 109 of the acts of 1888, approved November 27, 1888, entitled "An act to regulate the sale of commercial fertilizers," is hereby amended by inserting after section 11 of said act another section, which shall be numbered section 12, and shall read as follows: "All analyses of fertilizers provided for by this act, including the collection of samples of such analyses shall be made by the director of the Vermont Experiment Station at the expense of said station, and so much of the license fees collected under this act shall be paid by the State treasurer to the treasurer of said station as the director of said Experiment Station may show by his bills has been expended in performing the duties required by this act, but in no case to exceed the amount of the license fees received by the treasurer under this act, such payment to be made annually on or after the first day of September, upon the order of the auditor of accounts, who is hereby directed to draw his order for such purpose.

SEC. 2. Said act is further amended by changing the number of section 12 to section 13.

Approved November 14, 1894.

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## III. LICENSED FERTILIZERS SAMPLED BY THE STATION.

### Bowker Fertilizer Co., Boston, Mass.

**1533. Farm and Garden Phosphate**; from stocks of Joshua Upham, Weathersfield: A. E. Fuller, Woodstock; L. F. Fortney, Plainfield.

**1521. Hill and Drill Phosphate**; from stocks of D. C. Wright, Westminster; G. E. Pringle, East Charlotte; A. E. Fuller, Woodstock; L. F. Fortney, Plainfield.

**1522. Stockbridge Manure for Potatoes and Vegetables**; from stocks of John Mead, Middlebury; D. C. Wright, Westminster; A. C. Davis, Norwich; A. E. Fuller, Woodstock.

### Bradley Fertilizer Co., Boston, Mass.

**1504. Corn Phosphate**; from stocks of Randall & Crane, Greensboro; Sherman & Brady, Newport; Farrar, Burt & Co., Enosburg Falls; Howard & Brown, Ludlow; W. G. Stevens, Putney; O. L. Miner, Brattleboro; J. M. Johnson, West Pawlet; Dutton & Richard, Northfield; E. Foster, South Royalton.

**1502. Eclipse Phosphate for all Crops**; from stocks of Ira W. Thorp, Underhill; Farrar, Burt & Co., Enosburg Falls; Howard & Brown, Ludlow; A. G. Pierce, Burlington; H. M. Maxfield, Johnson; A. P. Fish, West Randolph; G. H. Tupper, Bethel.

**1503. Potato Fertilizer**; from stocks of Ira. W. Thorp, Underhill; G. H. Kay, Walden; Sherman & Brady, Newport; W. G. Stevens, Putney; A. G. Pierce, Burlington; H. M. Maxfield, Johnson; Dutton & Richard, Northfield; E. Foster, South Royalton; G. H. Tupper, Bethel.

**1523. Potato Manure**; from stocks of O. L. Miner, Brattleboro; Stone, Brewster & Co., Windsor; L. W. Loukes, Vergennes; Brooks & Berry, Montpelier.

**1501. X. L. Superphosphate of Lime**; from stocks of Ira W. Thorp, Underhill; G. Storey, Lyndonville; W. G. Stevens, Putney; O. L. Miner, Brattleboro; Dutton & Richard, Northfield; G. H. Tupper, Bethel; Sidney Davis, Norwich; N. M. Jones, Pawlet.

### Cleveland Dryer Co., Cleveland, O.

**1530. Corn and Grain Phosphate**; from stocks of W. H. Dunton, Sheldon Junction; L. A. Russell, Shrewsbury; M. M. Whipple, Bethel.

**1505. Fertilizer for all Crops**; from stocks of J. P. Telfer, Barton; W. H. Dunton, Sheldon Junction; C. R. Lane, Cornwall; L. A. Russell, Shrewsbury; A. E. Ellis, Richmond; A. P. Fish, West Randolph.

**1527. Potato Phosphate**; from stocks of W. H. Dunton, Sheldon Junction; L. A. Russell, Shrewsbury; M. M. Whipple, Bethel.

### E. Frank Coe & Co., New York, N. Y.

**1532. Ammoniated Bone Superphosphate (Standard Grade)**; from stocks of Silas Giddings, Castleton; J. H. George, St. Johnsbury; H. T. Baldwin, Wells River.

**1518. Columbian Potato Fertilizer**; from stocks of D. B. Hunter, Greensboro; James Cody, South Dorset; J. P. Lamson, West Randolph; E. E. Paul, Wells; W. H. Burbank, Barnet; H. T. Baldwin, Wells River.

**1525. Columbian Corn Fertilizer**; from stocks of James Cody, South Dorset; M. Burbank, Irasburgh; E. E. Paul, Wells; J. P. Lamson, West Randolph.

**1531. Celebrated Grass and Grain Fertilizer**; from stocks of D. B. Hunter, Greensboro; Farnsworth & Co., Middlebury; James Cody, South Dorset.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**1507. Ammoniated Corn Phosphate**; from stocks of E. B. Williams, Jericho; Drew and Post, Irasburgh; J. B. Taft, Brattleboro; A. C. Connors, Manchester; C. P. Smith, Wallingford; S. P. Curtis & Son, Rutland; G. W. Beecher, West Pawlet; A. F. Stevens, Richmond; W. A. Blake, Northfield; Rumsey and St. John, Castleton.

**1508. New Rival Ammoniated Superphosphate**; from stocks of E. B. Williams, Jericho; W. R. Parker, Enosburg Falls; E. O. Aldrich, Shrewsbury; J. B. Taft, Brattleboro; A. C. Connors. Manchester; C. P. Smith, Wallingford; G. W. Beecher, West Pawlet; A. F. Stevens, Richmond.

**1506. Potato, Hop and Tobacco Phosphate**; from stocks of E. B. Williams, Jericho; Drew and Post, Irasburgh; L. P. Jenne, Derby Center; W. R. Parker, Enosburg Falls; E. O. Aldrich, Shrewsbury; J. B. Taft, Brattleboro; A. C. Connors, Manchester; C. P. Smith, Wallingford; S. P. Curtis & Son, Rutland; G. W. Beecher, West Pawlet; A. F. Stevens, Richmond; W. A. Blake, Northfield; Rumsey and St. John, Castleton.

**1519. Superior Rye and Oats Phosphate**; from stocks of W. R. Parker, Enosburg Falls; J. B. Taft, Brattleboro; S. P. Curtis & Son, Rutland; G. W. Beecher, West Pawlet; E. W. Pitkin, Marshfield.

### Cumberland Bone Phosphate Co., Portland, Me.

**1509. Potato Fertilizer**; from stocks of W. H. Nye, Johnson; A. M. Foster, Cabot; T. G. Driscoll, St. Albans; Donahue and Allen, Essex Junction; W. P. Dodge, Chester; Valley Grain Co., Brattleboro; J. H. Hewitt, South Royalton.

**1524. Superphosphate**; from stocks of W. H. Nye, Johnson; W. P. Dodge, Chester; Valley Grain Co., Brattleboro; J. H. Hewitt, South Royalton.

### Lister's Agricultural Chemical Works, Newark, N. J.

**1528. Special Potato Fertilizer**; from stocks of C. D. Whitman, Brattleboro; Charles Chandler, Chester; Thomas Gagner, St. Johnsbury.

**1510. Success Fertilizer**; from stocks of C. D. Whitman, Brattleboro; R. J. Maranville, Wallingford; A. E. Ellis, Richmond; N. B. Denio, Pawlet; G. W. Bates, Springfield; Thomas Gagner, St. Johnsbury.

### Pacific Guano Co., Boston, Mass.

**1511. Soluble Pacific Guano**; from stocks of S. M. Bartlett, West Burke; W. P. Dodge, Chester; O. L. Miner, Brattleboro; F. A. Sheldon, Rupert; Hilton and Stevens, Richmond; Levi Rice, Springfield.

**1512. Special Potato and Tobacco Fertilizer**; from stocks of Allston & Russell, East Hardwick; F. R. Foote, West Cornwall; W. P. Dodge, Chester; F. A. Sheldon, Rupert; Hilton and Stevens, Richmond.

### Quinnipiac Co., Boston, Mass.

**1515. Climax Phosphate**; from stocks of Mellen & Proctor, Brattleboro; W. S. Holland, Townshend; C. E. Perkins, Castleton; H. G. Ballard, Wells; B. F. Weeks, St. Johnsbury.

**1513. Corn Manure**; from stocks of Brown & Skinner, Barton Landing; W. P. Dodge, Chester: B. F. Sleeper, Westminster; W. S. Holland, Townshend; J. H. Hewitt, South Royalton; Frank Dean, Pawlet; H. G. Ballard, Wells; B. F. Weeks, St. Johnsbury.

**1514. Potato and Tobacco Fertilizer**; from stocks of W. P. Dodge, Chester; B. F. Sleeper, Westminster; W. S. Holland, Townshend; J. H. Hewitt, South Royalton; H. G. Ballard, Wells.

### Read Fertilizer Co., Syracuse, N. Y.

**1526. Leader Guano**; from stocks of O. M. Derby, North Rupert; W. M. Smith, Chester; S. D. Whiting, Johnson; Perry Porter, West Burke.

**1529. Standard Superphosphate**; from stocks of W. M. Smith, Chester; S. D. Whiting, Johnson; Perry Porter, West Burke.

### Williams and Clark Co., New York, N. Y.

**1516. Americus Corn Phosphate**; from stocks of Allston and Russell, East Hardwick; Wheeler & Lock, Irasburgh; H. J. Stearns, Ludlow; D. H. Hewlett, Chester; O. L. Miner, Brattleboro; C. H. Willard, Townsend; F. J. Nelson, West Pawlet; J. H. Kiniry, Windsor; S. T. Dudley, West Concord.

**1520. Americus Potato and Tobacco Phosphate**; from stocks of Wheeler & Lock, Irasburgh; H. J. Stearns, Ludlow; D. H. Hewlett, Chester; C. H. Willard, Townsend; F. J. Nelson, West Pawlet; S. T. Dudley, West Concord; E. W. Gilman, Marshfield.

**1517. Royal Bone Phosphate**; from stocks of S. M. Bartlett, West Burke; H. J. Stearns, Ludlow; O. L. Miner, Brattleboro; F. J. Nelson, West Pawlet; J. H. Kiniry, Windsor.

## IV. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1533 | Bowker's Farm and Garden Phos | 0.86 | - - - | 1.05 | 1.91 | 1 6 | $ 6.05 | 4.00 | 3.64 | 5.67 | 13.31 | 10. | 7.64 | 8. | $11.07 | 1.95 | 2. | $1.78 | 1.31 | 1533 |
| 1521 | “ Hill and Drill Phosphate | 0.54 | 0.23 | 2.03 | 2.80 | 2.5 | 9.17 | 6.93 | 2.34 | 3.59 | 12.86 | 12. | 9.27 | 9. | 12.33 | 2.29 | 2. | 2.06 | 2.90 | 1521 |
| 1522 | “ Stckbdg. for Potat's, &c. | 1.43 | - - - | 1.81 | 3.24 | 3.25 | 10.26 | 6 28 | 2.39 | 2.20 | 10.87 | 8. | 8.67 | 6. | 11.05 | 7.37 | 7. | 6.63 | 7.60 | 1522 |
| 1504 | Bradley's Corn Phosphate | - - - | - - - | 2.36 | 2.36 | 2.05 | 7.79 | 6.70 | 2.26 | 2.16 | 11.12 | 10. | 8.96 | 9. | 11.39 | 2.07 | 1.5 | 1.86 | 2.11 | 1504 |
| 1502 | “ Eclipse Phosphate | - - - | 0.13 | 2.11 | 2.24 | 1. | 7.44 | 6.75 | 2.51 | 2.29 | 11.55 | 12. | 9.26 | 10. | 11.78 | 1.82 | 1.5 | 1.64 | 1.91 | 1502 |
| 1503 | “ Potato Fertilizer | 0.22 | 0.18 | 1.77 | 2.17 | 2.05 | 7.17 | 6.18 | 2.53 | 2.35 | 11.06 | 11. | 8.71 | 9. | 11.14 | 3.38 | 3.25 | 3.04 | 3.48 | 1503 |
| 1523 | “ Potato Manure | 0.21 | 0.16 | 2.16 | 2.53 | 2.5 | 8.36 | 3.92 | 2.19 | 2.29 | 8.40 | 8. | 6.11 | 6. | 8.03 | 5.31 | 5. | 4.78 | 5.65 | 1523 |
| 1501 | “ X. L. Superphos. of Lime | 0.44 | 0.18 | 1.91 | 2.53 | 2.5 | 8.29 | 7.00 | 2.56 | 1.72 | 11.28 | 11. | 9.56 | 9. | 11.91 | 2.58 | 2. | 2.32 | 2.26 | 1501 |
| 1530 | Cleveland Corn and Grain Phos. | 0.48 | 0.14 | 1.80 | 2.42 | 2.05 | 7.90 | 6.15 | 2.87 | 2.61 | 11.63 | 10.5 | 9.02 | 9.5 | 11.58 | 1.90 | 1.5 | 1.71 | 2.66 | 1530 |
| 1505 | “ Fertilizer for all Crops | - - - | - - - | 1.53 | 1.53 | 1.05 | 5.05 | 6.06 | 2.07 | 2.00 | 10.13 | 9. | 8.13 | 8. | 10.35 | 2.16 | 2. | 1.94 | 3.15 | 1505 |
| 1527 | “ Potato Phosphate | - - - | 0.13 | 2.01 | 2.14 | 2.05 | 7.11 | 5.96 | 2.81 | 2.16 | 10.93 | 10. | 8.77 | 8. | 11.10 | 3.23 | 3. | 2.91 | 3.98 | 1527 |
| 1532 | Coe's Ammo. Bone Superphosphate | - - - | 0.16 | 1.65 | 1.81 | 1.25 | 6 05 | 7.42 | 1.99 | 2.87 | 12.28 | 9. | 9.41 | 8. | 12.24 | 1.60 | 1.35 | 1.62 | 0.28 | 1532 |
| 1518 | “ Columbian Potato Fertilizer | - - - | - - - | 1.60 | 1.60 | 1. | 5.28 | 7.84 | 1.88 | 3.81 | 12.53 | 11. | 9.22 | 9. | 12.20 | 1.74 | 1.85 | 1.76 | 0.33 | 1518 |
| 1525 | “ Columbian Corn Fertilizer | - - - | 0.16 | 1.38 | 1.54 | 1. | 5.15 | 7.05 | 2.42 | 3.04 | 12.51 | 11. | 9.47 | 9. | 12.34 | 1.86 | 1.85 | 1.89 | 0.33 | 1525 |
| 1531 | “ Grass and Grain Fertilizer | - - - | - - - | 1.11 | 1.11 | 0.8 | 3 66 | 6.62 | 3.17 | 3.82 | 13.61 | 10. | 9.79 | 9. | 12.96 | 1.64 | 1.35 | 1.68 | 0.20 | 1531 |
| 1507 | Crocker's Ammo. Corn Phosphate | - - - | 0.16 | 2.02 | 2.18 | 2. | 7.26 | 7.56 | 2.63 | 1.68 | 11.82 | 11. | 10.19 | 10. | 12.62 | 1.92 | 1.6 | 1.73 | 1.39 | 1507 |
| 1508 | “ New Rival Ammo. Sup. | - - - | - - - | 1.44 | 1.44 | 1.2 | 4.75 | 6.83 | 3.39 | 1.35 | 11.57 | 11. | 10.22 | 10. | 12.47 | 1.81 | 1.6 | 1.73 | 0.85 | 1508 |

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | Chlorin. | Station. |
| 506 | Crocker's Potato, Hop & Tobacco. | - - - | 0.18 | 1.92 | 2.10 | 2 | $7.00 | 7.89 | 2.28 | 1.17 | 11 34 | 11 | 10.17 | 10 | $12.44 | 3.52 | 3.25 | $3.17 | 3.14 | 1506 |
| 519 | " Superior Rye & Oats Phos. | - - - | - - - | 1.34 | 1.34 | 0.82 | 4.42 | 5.84 | 2.52 | 2.44 | 10.80 | 9 | 8.36 | 8 | 10.76 | 1.98 | 2 | 1.78 | 2.04 | 1519 |
| 509 | Cumberland Potato Fertilizer...... | 0.44 | 0.13 | 1.54 | 2.11 | 2.05 | 6.88 | 5.33 | 3.18 | 2.94 | 11.45 | 11 | 8 51 | 9 | 11.07 | 3.33 | 3 | 3.00 | 4.10 | 1509 |
| 524 | " Superphosphate....... | 0.21 | 0.16 | 2.06 | 2.43 | 2.06 | 8.02 | 6.78 | 2.34 | 1.77 | 10.89 | 10 | 9.12 | 8 | 11.42 | 2.36 | 2 | 2.12 | 2.95 | 1524 |
| 528 | Lister's Special Potato Fertilizer.. | - - - | 0.28 | 1.61 | 1.89 | 1.64 | 6.35 | 6.13 | 2.35 | 2.51 | 10.99 | .... | 8.48 | 8 | 10.95 | 2.90 | 3 | 2.61 | 2.83 | 1528 |
| 510 | " Success Fertilizer.......... | - - - | 0.27 | 1.38 | 1.65 | 1.25 | 5.55 | 7.50 | 1.49 | 2.67 | 11.66 | .... | 8.99 | 9 | 11.71 | 2.01 | 2 | 1.81 | 2.02 | 1510 |
| 511 | P. G. Co's Soluble Pacific Guano... | - - - | 0.18 | 2.19 | 2.37 | 2 25 | 7.89 | 6.90 | 1.81 | 1.80 | 10.51 | 10.5 | 8.71 | 8.5 | 10 99 | 2.53 | 2 | 2.28 | 8.04 | 1511 |
| 512 | " Special Potato & Tobac. | 0.52 | - - - | 1.79 | 2.31 | 2. | 7.47 | 6.04 | 2.23 | 2.46 | 10.73 | 9 | 8.27 | 8 | 10.69 | 3.27 | 3 | 2.94 | 4.69 | 1512 |
| 515 | Quinnipiac Climax Phosphate .... | - - - | - - - | 1.27 | 1.27 | 1.03 | 4.19 | 6.50 | 1.71 | 1.44 | 9.65 | 9 | 8.21 | 8 | 10.26 | 2.54 | 2 | 2.29 | 3.11 | 1515 |
| 513 | " Corn Manure........... | 0.24 | 0.14 | 1.84 | 2.22 | 2.06 | 7.31 | 6.14 | 2.85 | 2.43 | 11.42 | 10 | 8.99 | 9 | 11.48 | 1.94 | 1.5 | 1.75 | 2.49 | 1513 |
| 514 | " Potato & Tobacco Fert. | 0.38 | 0.13 | 1.80 | 2.31 | 2.05 | 7.56 | 5.97 | 2.18 | 2.57 | 10.72 | 9 | 8.15 | 8 | 10.59 | 2.85 | 3 | 2.57 | 3.51 | 1514 |
| 526 | Read's Leader Guano............... | 0.17 | - - - | 1.01 | 1.18 | 0.82 | 3.84 | 4.50 | 2.32 | 1.44 | 8.26 | 8 | 6 82 | 7 | 8.53 | 2.43 | 2 | 2.19 | 5.18 | 1526 |
| 529 | " Standard Superphosphate.. | 0.22 | - - - | 1.01 | 1.23 | 0.82 | 3.99 | 6.04 | 1.93 | 1.09 | 9.06 | 10 | 7.97 | 8 | 9.81 | 4.09 | 4 | 3.68 | 7.82 | 1529 |
| 516 | W. & C. Co.'s Ammo. Corn Phos... | 0.35 | 0.13 | 1.80 | 2 28 | 2.05 | 7.47 | 6.19 | 2.66 | 2.65 | 11.50 | 10 | 8.85 | 9 | 11.41 | 1.72 | 1.5 | 1.55 | 2.32 | 1516 |
| 520 | " Ammo. Potato & Tobac. | - - - | 0.14 | 2.03 | 2.17 | 2.05 | 7.22 | 6.17 | 2.83 | 2.45 | 11.45 | 9 | 9.00 | 8 | 11.50 | 3.17 | 3 | 2.85 | 2.94 | 1520 |
| 517 | " Royal Bone Phosphate | - - - | - - - | 1.32 | 1.32 | 1.03 | 4.36 | 6.12 | 1.60 | 1.77 | 9.49 | 8 | 7.72 | 7 | 9.82 | 2.56 | 2 | 2.30 | 3.18 | 1517 |

## V. BRANDS NOT REPORTED IN THIS BULLETIN.

Analyses of single samples of the following brands were reported in Bulletin 45.

Bowker's Hill and Drill Phosphate.
Bradley's X. L. Superphosphate.
Clark's Cove Bay State Fertilizer.
Cleveland Corn and Grain Fertilizer.
Coe's High Grade Ammoniated Bone Superphosphate.
Crocker's Ammoniated Corn Phosphate.
Cumberland Fertilizer.
Cumberland Superphosphate.
Lister's Success Fertilizer.
Pacific Guano Co.'s Soluble Pacific Guano.
Powers, Gibbs & Co.'s Sea Bird Guano.
Quinnipiac Phosphate.
Read's Farmers' Friend Superphosphate.
Standard Fertilizer.
Williams & Clark Co.'s Americus Ammoniated Bone Superphosphate.

Samples of the following brands are in the laboratory and their analyses will be published on completion in Bulletin 47. In no case have more than two samples of each of these brands been found by the Station agents.

BOWKER FERTILIZER CO., Boston, Mass.

Corn Phosphate.
Fish and Potash.
Grain and Fodder Corn Manure.
Potato and Vegetable Manure.
Potato Phosphate.
Stockbridge Manure for Corn.
" " " Seeding Down.
" " " Top Dressing.
Sure Crop Phosphate.
Superphosphate with Potash.
Ten Per Cent. Manure.

BRADLEY FERTILIZER CO., Boston, Mass.

B. D. Sea Fowl Guano.
Complete Manure for Top Dressing Grass and Grain.
Ground Bone and Potash.
Seeding Down Manure.

CLARK'S COVE GUANO CO., Boston, Mass.

Potato and Tobacco Fertilizer.

CLEVELAND DRYER CO., Cleveland, O.

Cleveland Superphosphate.

E. FRANK COE CO., New York, N. Y.

Columbian Brand Ammoniated Bone Superphosphate.
Excelsior Potato Fertilizer.
Gold Brand Excelsior Guano.
High Grade Potato Fertilizer.
Celebrated Special Potato Fertilizer.

CUMBERLAND BONE PHOSPHATE CO., Portland, Me.

Seeding Down Fertilizer.

GREAT EASTERN FERTILIZER CO., Rutland, Vt.

General for Grain and Grass.
" Grass and Oats Phosphate.
" for Oats, Buckwheat and Seeding Down.
" Soluble Bone and Potash Fertilizer.
" Vegetable, Vine and Tobacco Fertilizer.
" Wheat Special.

LISTER'S AGRICULTURAL CHEMICAL WORKS, Newark, N. J.

Animal Bone and Potash.
Corn Fertilizer.
Potato Fertilizer No. 2.

PACIFIC GUANO CO., Boston, Mass.

Nobsque Guano.

POWERS, GIBBS & CO., Wilmington, N. C.

Almont Brand Ammoniated Guano.
Special Potato Guano.
Special Small Grain Guano.

QUINNIPIAC CO., Boston, Mass.

Market Garden Manure.
Potato Manure.

**STANDARD FERTILIZER CO., Boston, Mass.**

A Brand.
Guano.
Potato and Tobacco Fertilizer.

**WILLIAMS & CLARK CO., New York, N. Y.**

Americus Potato Phosphate.

1895.

## VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 47.

MAY, 1895.

# Commercial Fertilizers.

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BURLINGTON :
FREE PRESS ASSOCIATION,
1895.

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 47. COMMERCIAL FERTILIZERS.

BY J. L. HILLS AND B. O. WHITE.

## I. SUMMARY.*

**III. The trade values of fertilizing ingredients in mixed goods this year are 15, 18½ and 16½ cents per pound for nitrogen in nitrates, ammonia salts and in organic forms respectively; 6, 5½ and 2 cents per pound for soluble and reverted, and insoluble phosphoric acids; 5¼ and 4¼ cents per pound for sulphate and muriate of potash. (Bul. 45. p. 4).**

*These trade values do not represent the proper selling prices of mixed goods at the point of consumption,* **but are the retail cash prices, of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance. (Bul. 45, p. 5).**

**The Station has analyzed samples of ninety-two distinct brands of fertilizers, all taken this spring from dealers' stocks and all this year's goods. This is thirty-nine more than were analyzed in 1894 and fifty-six more than in any year previous to that time.**

**Of the ninety-two brands analyzed, sixty, or two-thirds are above guarantee in nitrogen, available phosphoric acid and potash; twenty-six, or a little more than a fourth, are deficient in a single ingredient; seven, or one-twelfth are deficient in two ingredients. Of the thirty-three brands found deficient, twenty-nine are but slightly so or show by their analyses imperfect mixing at the factory. They contain a sufficient excess of other ingredients to afford an equivalent money value. It is safe to say that ninety-five per cent of the brands sold in the State this year contain the commercial equivalent of their guarantees. (Pages 49-57).**

**IV. The average composition of forty-seven brands sold in Vermont in 1894 and 1895 differs but slightly, the increase in valuation being but thirty-four cents. The average goods are of poorer quality than those sold before 1894. Owing to lower prices for mixed goods and the slight increase in valuation of the average of all goods, plant food is bought this year in commercial fertilizers as low as at any time within the past eleven years. (Page 58-59).**

**V. Seventeen samples of ashes varied from 3.36 to 9.53 per cent. soluble potash and from 1.47 to 5.23 per cent. phosphoric acid. The prices for these goods were not in accordance with their composition. It is always best to buy ashes on the analysis of the Experiment Station. (Page 60).**

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* This summary refers in part to Bulletin 45 inasmuch as the trade values there given are used in calculating the Station valuations in this bulletin. No attempt is made to summarize the portion of this bulletin under the heading "II. Fertilizers and Fertilization." The matter contained therein is so closely written that it does not admit of successful condensation. Reference to the sub-heads on the title page will enable the reader to find readily any particular portion of the matter.

## II. FERTILIZERS AND FERTILIZATION.

There has been no publication made by this Station since 1889 explaining the meaning of the terms employed in fertilizer analysis. Our mailing list has increased much since that time and the many inquiries received indicate a desire for more information upon the general subject of fertilization. It seems wise therefore to issue in connection with the final bulletin of fertilizer analyses for the year, explanations upon the following points:

(1) The principles governing the use of fertilizers.
(2) The elements of plant food.
(3) The materials used in commercial fertilizers, their description, source and composition.
(4) The specific action of nitrogen, phosphoric acid and potash upon vegetable growth.
(5) The selection, purchase and use of commercial fertilizers.
(6) Explanation of terms used in fertilizer guarantees and analyses.

### 1. PRINCIPLES GOVERNING THE USE OF FERTILIZERS.

The following clear and concise statement of the principles governing the use of fertilizers was made by the famous German chemist, Justus von Liebig, in 1840. Before that time fertilization was without a rational and scientific basis; since then no one has been able successfully to controvert his statements.

1. "A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants, in the required quantity, and in the proper form."

2. "With every crop a portion of these ingredients is removed. A part of this portion is again added from the inexhaustible store of the atmosphere; another part, however, is lost forever if not replaced by man."

3. "The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land. Such a restitution is effected by manure."

4. "The manure produced in the course of husbandry is not sufficient to maintain permanently the fertility of a farm; it lacks the constituents which are annually exported in the shape of grain, hay, milk and live stock."

### 2. THE ELEMENTS OF PLANT FOOD.

Chemistry has shown that all matter is composed of from sixty-five to seventy chemical elements or substances which thus far have not been divided into two or more different kinds of matter. It has also shown that but fourteen of these are necessary to animal and vegetable life. These fourteen essential elements naturally fall into two distinct classes according to their sources.

1) **AIR-DERIVED ELEMENTS:**

*Carbon, Hydrogen, Oxygen, Nitrogen.*

(2) **SOIL-DERIVED ELEMENTS:**

(a) *Phosphorus, Sulphur, Chlorin, Silicon.*

(b) *Calcium, Iron, Potassium, Sodium, Magnesium, Manganese.*

The air-derived and first four soil-derived elements (a) are acid-forming elements; the last six soil-derived elements (b) are metals.

The air-derived elements come from the air directly or indirectly, and are, for the most part, driven off as gases, if the material is burned. They comprise fully 95 per cent of the gross weight of the vegetable kingdom. The soil-derived elements are of soil origin only, and are left as ash after the material is burned. They form from 1 to 10 per cent of the gross weight of ordinary plants. The proportion in which these elements enter into different vegetable substances varies with the nature of plant, stage of growth, etc. The following table* shows the amounts of these various elements removed by a crop of mixed grasses from an acre. The crop is assumed to weigh five tons when green, equivalent to a ton and a half to two tons of hay.

COMPOSITION OF MIXED GRASSES FROM AN ACRE.

| | Pounds. | Element. | Pounds. |
|---|---|---|---|
| Water | 7500 | Oxygen | 6667. |
| | | Hydrogen | 833. |
| Combustible or Organic Matter | 2300 | Oxygen | 950. |
| | | Hydrogen | 130. |
| | | Carbon | 1175. |
| | | *Nitrogen* | 45. |
| Ash or Inorganic Matter | 200 | *Potassium* | 41.5† |
| | | *Phosphorus* | 4.9‡ |
| | | Calcium | 18.1 |
| | | Magnesium | 5.4 |
| | | Iron and Manganese | 0.4 |
| | | Sodium | 7.8 |
| | | Sulphur | 3.8 |
| | | Chlorin | 14.5 |
| | | Silicon | 32.5 |
| | | Oxygen(combined with inorganic elements) | 71. |
| | 10,000 | | 10,000 |

The entire weight of the green grass contained 76.9 per cent oxygen, 9.6 per cent hydrogen, and 11.8 per cent carbon, or 98.3 per cent of these air derived elements, while the ten soil-derived elements together with nitrogen formed but 1.7 per cent of the weight of the crop. These figures serve to show the paramount importance to the plant of the air-derived elements especially in the form of water. It must not be inferred from this however that the soil-derived elements are relatively unimportant.

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*Taken with some modifications from Md. Agl. Expt. Stat. Bul. 6, p. 76.

†Equivalent to 50 pounds of potash. ‡Equivalent to 11.3 pounds of phosphoric acid.

The precise office in the plant economy of manganese, soda, chlorin and silicon is not known; some consider them of accidental occurrence, yet since they are found where plants grow under natural conditions it seems likely that they have their uses. The other ten elements are all necessary and plants grown in the absence of any one of them are stunted. Soils usually contain enough of all these elements except *Nitrogen, Phosphoric Acid and Potash* to supply plant needs forever.

These, because of their ready exhaustion, are known as the *deficient essential elements of plant food.* They alone are the elements desired when direct fertilizers of any kind, natural or artificial, are applied.

We will therefore describe them in some detail.

## NITROGEN.

*Nitrogen* occurs in nature—

(a) As a constituent of the air uncombined with other elements, a colorless, tasteless, odorless gas, forming about four-fifths of the bulk of the atmosphere.

(b) In the form of nitrates, combined with hydrogen and oxygen, forming nitric acid ($HNO_3$)*, which combining with metals forms salts.

(c) In the form of ammonia ($NH_3$), combined with hydrogen, forming the colorless gas of familiar pungent odor. It is present in the air in very small quantities and is formed by the decomposition of organic bodies containing nitrogen.

(d) In several forms of animal and vegetable matter, combined with carbon, hydrogen, oxygen, and sometimes small quantities of other elements; the fibrin of blood and flesh, casein of milk, albumen of white of egg, etc., are types of these materials.

## PHOSPHORIC ACID.

Phosphorus occurs in nature combined with oxygen as phosphoric acid ($P_2O_5$).

(a) In animal bones.

(b) In various mineral deposits.

(c) In soils and ores.

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*For convenience in writing chemical formulas, an abbreviation for each element is used by chemists. This is usually the first letter of the name of the element. (H—hydrogen, O—oxygen). Figures below and to the right of a letter represent the number of atoms of that element in a molecule of the substance. Thus the formula for nitric acid ($HNO_3$) indicates that its molecule contains one atom of hydrogen, one atom of nitrogen and three atoms of oxygen.

Pure phosphorus is a soft, yellow, waxy solid, poisonous and inflammable. Phosphoric acid is usually combined with lime, iron or alumina.

There are four lime phosphates* used in fertilizers, viz.:

(a) Mono-calcic phosphate, furnishing "soluble" phosphoric acid.
(b) Di-calcic phosphate, furnishing "reverted" phosphoric acid.
(c) Tri-calcic phosphate, furnishing "insoluble" phosphoric acid.
(d) Tetra-calcic phosphate, found in Thomas slag.

These phosphates have respectively one molecule or part of phosphoric acid ($P_2O_5$) united with one (mono-), two (di-), three (tri-) or four (tetra- molecules or parts of lime (CaO). The third or tri-calcic phosphate is the only one found in nature, the other three being artificial products; it forms about one-half the weight of dry raw bone and forms from half to three-quarters the weight of many mineral phosphates.

The tri-calcic phosphate or insoluble phosphate of lime is but slowly available to the plant, for the phosphoric acid is firmly bound by the three molecules or parts of lime. It has been found, however, that if a stronger acid (sulphuric acid or oil of vitriol) is added in sufficient quantities to a lime phosphate, the grasp of two-thirds of the lime is transferred from the phosphoric to the sulphuric acid, thus loosening the bonds of the former and rendering it soluble. Two molecules or parts of the lime unite with the sulphuric acid to form sulphate of lime or gypsum, and the phosphoric acid remains held by but a single molecule or part of lime as mono-calcic phosphate. This mixture of mono- or soluble calcic phosphate and gypsum is what is known in the trade as superphosphate of lime; its phosphoric acid is readily soluble in water and is agriculturally in its most valuable form. If too little sulphuric acid is used, if the goods remain in piles before using, or if iron and alumina are present,more or less di-calcic or "reverted" phosphate is formed. This occurs at the time of manufacture if the sulphuric acid is short, or on standing in either of the other contingencies. This reverted form is not dissolved by water, but is soluble in certain chemicals, and is sufficiently soluble in root and soil acids to steadily nourish the growing plant. It is called "reverted" because much of it had once been soluble in water and had reverted or gone back to a relatively insoluble state. It is believed that much of the soluble phosphoric acid becomes reverted in the soil. The two forms are usually grouped together in trade parlance and spoken of as "available phosphoric acid" and have much the same agricultural and commercial value.

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*These phosphates have various names in the trade, as follows: *Mono-calcic phosphate;* mono-basic phosphate, acid-calcium phosphate, acid phosphate, superphosphate of lime, soluble bone phosphate. *Di-calcic phosphate;* di-basic phosphate, reverted calcium phosphate, returned phosphate, precipitated phosphate of lime, reverted or back gone phos phate. *Tri-calcic phosphate;* tri-basic phosphate, insoluble phosphate of lime, phosphate of lime, calcium phosphate, bone phosphate of lime. *Tetra-calcic phosphate* is only known in Thomas slag or odorless phosphate.

### POTASH.

*Potassium*, which combines with oxygen to form potash, ($K_2O$) is not found uncombined in nature, but occurs:

(a) as a constituent of many minerals.

(b) in various vegetable matters and their ashes.

Alone and uncombined it is a light, silvery metal.

It comes into fertilization—

(a) as chlorid in muriate of potash, kainit, etc.

(b) as sulphate in sulphate of potash, double manure salt, etc.

(c) as carbonate (and some silicate) in wood ashes, etc.

(d) as organic potash in cottonseed meal, tobacco stems, castor pomace, etc.

The first three forms are soluble in water; the fourth only partially soluble, but available on decomposition.

## 3. MATERIALS USED IN MANUFACTURE OF COMMERCIAL FERTILIZERS.

All genuine commercial fertilizers, whatever brand the bags bear, owe their value to the kind, quality and amount of nitrogen, phosphoric acid and potash they contain. They are made by mixing more or less of several kinds of crude stock furnishing the desired ingredients, including sulphuric acid (oil of vitriol) to dissolve the phosphate and make it soluble. Following will be found short descriptions of the various kinds of crude stock more commonly used in the class of goods sold in this state. Average analyses of the same will be found tabulated on pages 33-34.

### NITROGENOUS CRUDE STOCK.

FURNISHING NITRIC NITROGEN. *Nitrate of Soda* (Chili Saltpeter), heavy, white, crystalline salt; mined from large deposits in rainless regions of Northern Chili; readily soluble and immediately available; may be lost by leaching if applied too far in advance of growing season and in too large quantities: at present cheapest of the better forms of nitrogen.

FURNISHING AMMONICAL NITROGEN. *Sulphate of Ammonia;* heavy, finely crystalline, dirty white salt; refuse product of coal gas manufacture; readily soluble, but, since it must undergo nitrification before it becomes available, not quite so quickly acting as nitrate of soda; thought to be positively detrimental to plant growth on some soils;* at present most expensive form of nitrogen.

FURNISHING ORGANIC NITROGEN (Animal). *Azotin or Ammonite;* ground meat, membrane, tendons, etc., from which fat has been extracted.

*Dried Blood;* slaughter-house blood, evaporated, dried and ground; dark-red (hog), nearly black (cattle).

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*R. I. Expt. Stat. Rpt. for 1893, pp. 206-267.

*Dry Ground Fish; Fish Scrap;* residue from Menhaden fish oil works; valuable in proportion to dryness and fineness; contains some phosphoric acid; sometimes acidulated to check putrefaction and to dissolve the phosphoric acid.

*Meat Scraps; Tankage;* dried and ground slaughter-house refuse; usually contain more bone than azotin or ammonite, and hence contains some phosphoric acid.

Azotin, ammonite, dried blood, dry ground fish, meat scrap and tankage if dry and finely ground furnish the best grades of animal organic nitrogen and although not directly soluble, become readily available through decomposition and the influences of the nitrifying bacteria.

*Hair; Horn Dust; Wool Waste;* manufacturing by products; but slowly available; rated at lower prices than preceding.

*Leather Scrap;* manufacturing by product; practically useless as a fertilizer because so slowly available; in most States its use in commercial fertilizers is forbidden by law; of but little money value as a fertilizer.

FURNISHING ORGANIC NITROGEN (Vegetable). *Cotton Seed Meal;* residue from cotton seed oil works, dried and ground; if bright and undamaged by heating, best used as cattle food, since nearly all the fertilizing value may be recovered in the manure, but profitable at present prices to apply directly as a fertilizer; readily available; contains considerable phosphoric acid and potash.

*Castor Pomace;* residue from castor oil works; dried and ground; not as rich as most cotton seed meals.

### PHOSPHATIC CRUDE STOCK.

FURNISHING INSOLUBLE PHOSPHORIC ACID (Animal). *Bone Ash;* residue from burning bone; produced mainly in Argentine Republic; nitrogen is driven off but phosphoric acid remains.

*Bone Black;* spent bone black from sugar refineries, where it is used to clarify sugar; made by burning bones without access of air in much the same manner as charcoal; nitrogen is driven off but phosphoric acid remains.

*Ground Bone;* dried and ground (sometimes steamed or extracted) bone; contains nitrogen and phosphoric acid; valuable in proportion to analysis and fineness of grinding.

FURNISHING INSOLUBLE PHOSPHORIC ACID (Mineral). *Apatite;* hard, green or brown crystalline rock; mined in Canada; not used much in United States goods.

*Phosphate Rock;* found in many places in various parts of the world; that used in this country comes mainly from Florida, South Carolina, Tennessee and the West Indies.

*Florida Rock;* found in river beds as fine black pebbles, and on land as light brown to white pebble, drift or soft rock, and bowlder or hard rock; deposits located in central southern part of the State, of enormous extent; mined by dredges (river) and by digging (land); dried by hot air blast; ground before used.

*South Carolina Rock;* found in shallow undulating strata underlaying land, rivers and salt water estuaries near sea coast from Charleston to Beaufort, S. C., occurring in irregular nodules with rough, indented, honey-combed surface, of all sizes, black, grey, yellow and white; mined by dredges (river) and by trenching (land); dried by hot air blast; ground before used.

*Tennessee Rock;* recently discovered and but newly worked.

*West Indies Rock;* from several W. I. islands, of various kinds and qualities; obtained by digging and mining.

The Florida and South Carolina deposits contain many animal remains, teeth, bones, etc.

*Thomas Slag* (*Peine-Thomas Scoria*, *Odorless Phosphate*); a waste or by-product from the basic Bessemer process of steel manufacture, the phosphorus of the pig iron being transferred to the lime lining of the furnace; the phosphoric acid and lime are combined as tetra-phosphate, a combination not known in any other material; probably because of its over saturation, its phosphoric acid, though insoluble in water, is more readily available to plant uses than that of other insoluble phosphates.

FURNISHING AVAILABLE PHOSPHORIC ACID (Animal.) *Dissolved Bone and Dissolved Bone Black* (*Bone Black Superphosphate;* bone and bone black treated with sulphuric acid (oil of vitriol) to render the phosphoric acid soluble and available (see p. 29); owing to absence of iron and alumina and carbonate of lime, and to better drying qualities of bone black, more sulphuric acid can safely be used, less insoluble phosphate left untouched and practically all the phosphoric acid made available; true "dissoived bone" or "soluble bone" should contain nitrogen, but much of the material on the market thus named is simply dissolved South Carolina or Florida rock.

FURNISHING AVAILABLE PHOSPHORIC ACID (Mineral). *Acid Phosphate* (*Superphosphate of Lime*, *Dissolved S. C. or Fla. rock*); ground phosphate rock dissolved or "cut" with sulphuric acid. Owing to reversion already explained (see p. 29) and to the sticky nature of the product if the full amount of acid is used, the goods usually contain more or less reverted and insoluble phosphoric acid.

### POTASSIC CRUDE STOCK.

FURNISHING POTASH AS CHLORID. *Muriate of Potash;* fine white crystalline salt; soluble in water and readily available; mined and purified at Stassfurt, northern Germany.

*Kainit;* coarser than muriate; dirty white crystalline salt; soluble in water and readily available; natural product of Stassfurt mines; contains both sulphates and chlorids.

FURNISHING POTASH AS SULPHATE. *Sulphate of Potash;* fine white crystalline salt (sometimes tinged with yellow or pink); soluble in water and readily available; mined and purified at Stassfurt.

*Double Sulphate of Potash and Magnesia,* (double manure salt); same description as sulphate of potash.

Other but less important potash salts obtained at Stassfurt are Carnallite, Krugit, Sylvanite, etc.

FURNISHING POTASH AS CARBONATE. *Wood Ashes;* of very variable composition according to the character of the wood used and care taken in preservation; unleached hard wood ashes usually contain from 4 to 8 per cent potash, and 1 to 3 per cent phosphoric acid; leached ashes, from one per cent potash upwards; lime kiln and brick kiln ashes are usually of inferior quality; coal ashes have practically no plant food in them: wood ashes are best bought on Experiment Station analysis and most dealers sell subject thereto; potash is usually readily available.

*Cotton Seed Hull Ashes;* ash from cotton seed hulls, largely used as fuel at Southern cotton seed oil factories, are of very variable composition, but rich in potash and phosphoric acid; are best bought on the analysis of the Experiment Station; potash is readily available.

FURNISHING POTASH IN ORGANIC MATTER (Vegetable). *Tobacco Stems;* when finely ground are quite effective but are less readily available than other forms of potash; contain nitrogen.

*Castor Pomace; Cotton Seed Meal;* already described, contain more or less potash.

The following tables show the average composition of the principal fertilizing materials offered for sale in our New England markets, together with analyses of several natural manurial products and farm manures, taken with some changes from the compilation in Bulletins 82 and 55 of the New York (Geneva) Experiment Station.

## COMPILATION OF ANALYSES OF COMMERCIAL FERTILIZING MATERIALS.

| Name of Substance. | Moisture. | Nitrogen. | Potash. | Phosphoric Acid. | | | Valuation[*] per ton of 2000 lbs |
|---|---|---|---|---|---|---|---|
| | | | | Available. | Insoluble. | Total. | |
| *A. Materials containing nitrogen.* | | | | | | | |
| Ammonite or Azotin | 5.88 | 11.33 | ---- | ---- | ---- | 3.43 | $41.16 |
| Castor pomace | 9.98 | 5.56 | 1.12 | ---- | ---- | 2.16 | 20.96 |
| Cotton-seed meal | 6.80 | 6.66 | 1.62 | ---- | ---- | 1.45 | 18.07[‡] |
| Dried blood | 12.50 | 10.52 | ---- | ---- | ---- | 1.91 | 36.63 |
| Dried fish | 12.75 | 7.25 | 0.45 | 3.05 | 5.20 | 8.25 | 32.36 |
| Horn and hoof waste | 10.17 | 13.25 | ---- | ---- | ---- | 1.83 | 13.97[¶] |
| Leather | ---- | 7.94 | ---- | ---- | ---- | ---- | ---- |
| Meat scrap | 12.09 | 10.44 | ---- | ---- | ---- | 2.07 | 36.52 |
| Nitrate of soda | 2.00 | 16.00 | ---- | ---- | ---- | ---- | 48.00 |
| Oleomargarine refuse | 8.54 | 12.12 | ---- | ---- | ---- | 0.88 | 40.88 |
| Sulphate of ammonia | 1.00 | 20.50 | ---- | ---- | ---- | ---- | 75.85 |
| Tankage | 13.20 | 6.82 | ---- | 5.02 | 6.23 | 11.25 | 32.88 |
| Tobacco stems | 10.61 | 2.29 | 6.44 | ---- | ---- | 0.60 | 13.96 |
| Wool waste | 9.27 | 5.64 | 1.30 | ---- | ---- | 0.29 | 7.30[¶] |
| *B. Materials containing phosphoric acid.* | | | | | | | |
| Apatite | ---- | ---- | ---- | ---- | ---- | 36.08 | 14.43 |
| Bone ash | 7.00 | ---- | ---- | ---- | ---- | 35.89 | 14.35 |
| Bone black | 4.60 | ---- | ---- | ---- | ---- | 28.28 | 11.31 |
| Bone black (dissolved) | ---- | ---- | ---- | 16.70 | 0.30 | 17.00 | 20.16 |
| Bone meal | 7.47 | 4.12 | ---- | 8.28 | 15.22 | 23.50 | 39.03 |
| Bone meal (from glue factory) | ---- | 1.70 | ---- | ---- | ---- | 29.90 | 38.33 |
| Bone meal (dissolved) | ---- | 2.60 | ---- | 13.53 | 4.07 | 17.60 | 26.11 |
| Caribbean guano | ---- | ---- | ---- | ---- | ---- | 18.90 | 7.56 |
| Cuba guano | 24.27 | 1.67 | ---- | ---- | ---- | 13.85 | 10.85 |
| Florida rock | 2.07 | ---- | ---- | ---- | ---- | 26.78 | 10.71 |
| Keystone concentrated phosphte | 1.50 | ---- | ---- | 38.81 | 8.94 | 47.75 | 50.15 |
| Mona Island guano | 12.52 | 0.76 | ---- | 7.55 | 14.33 | 21.88 | 14.04 |
| Navassa phosphate | 7.60 | ---- | ---- | ---- | ---- | 34.27 | 13.71 |
| Orchilla guano | 7.31 | ---- | ---- | ---- | ---- | 26.77 | 10.71 |
| Peruvian guano | 14.81 | 7.85 | 2.61 | 8.36 | 6.90 | 15.26 | 37.91 |
| S. Carolina rock (ground) | 1.50 | ---- | ---- | 0.60 | 27.43 | 28.03 | 11.21 |
| S. Carolina rock (floats) | ---- | ---- | ---- | ---- | ---- | 27.20 | 10.88 |
| S. Carolina rock (dissolved) | ---- | ---- | ---- | 11.60 | 3.60 | 15.20 | 15.16 |
| Thomas slag (Amer.) | ---- | ---- | ---- | ---- | ---- | 21.37 | 8.55 |
| Thomas slag (English) | ---- | ---- | ---- | 6.09 | 13.31 | 19.40 | 7.76 |
| Thomas slag (German) | ---- | ---- | ---- | ---- | ---- | 30.51 | 12.20 |

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[*] At 1895 trade values.

[¶] Nitrogen in these forms is rated at but 5 cts. a pound.

[‡] At present prices a very cheap form of nitrogen. It rates in trade values at but 12 cts. per pound because of low prices, yet is probably fully as available as the nitrogen in forms rating at 16–16½ cts., at which figures valuation would be $24.07.

## COMPILATION OF ANALYSES OF COMMERCIAL FERTILIZING MATERIALS.—CONTINUED.

| Name of Substance. | Moisture. | Nitrogen. | Potash. | Phosphoric Acid. | | | Valuation per ton of 2000 lbs. |
|---|---|---|---|---|---|---|---|
| | | | | Available. | Insoluble. | Total. | |
| *C. Materials containing potash* | | | | | | | |
| Carnallite | ---- | ---- | 13.68 | ---- | ---- | ---- | 12.31 |
| Cotton-seed hull ashes | 7.33 | ---- | 23.80 | ---- | ---- | 8.50 | 34.34 |
| Kainit | 3.20 | ---- | 13.54 | ---- | ---- | ---- | 12.19 |
| Krugit | 4.82 | ---- | 8.42 | ---- | ---- | ---- | 7.58 |
| Muriate of potash | 2.00 | ---- | 52.46 | ---- | ---- | ---- | 47.21 |
| Spent tan-bark ashes | 6.81 | ---- | 2.04 | ---- | ---- | 1.61 | 3.75 |
| Sulphate potash (high grade) | 1.25 | ---- | 38.60 | ---- | ---- | ---- | 40.53 |
| Sulphate potash and magnesia | 4.75 | ---- | 23.50 | ---- | ---- | ---- | 24.68 |
| Sylvinite | 7.25 | ---- | 16.65 | ---- | ---- | ---- | 14.98 |
| Wood ashes (unleached) | 12.00 | ---- | 5.50 | ---- | ---- | 1.85 | 7.63 |
| Wood ashes (leached) | ---- | ---- | 1.10 | ---- | ---- | 1.40 | 2.56 |
| *D. Miscellaneous materials.* | | | | | | | |
| Ashes (anthracite coal) | ---- | ---- | 0.10 | ---- | ---- | 0.10 | |
| Ashes (bituminous coal) | ---- | ---- | 0.40 | ---- | ---- | 0.40 | |
| Ashes (lime kiln) | 15.45 | ---- | 0.86 | ---- | ---- | 1.18 | |
| Marls (Massachusetts) | 18.18 | ---- | ---- | ---- | ---- | 1.05 | |
| Marls (North Carolina) | 1.50 | ---- | 0.04 | ---- | ---- | 0.56 | |
| Marls (Virginia) | 15.98 | ---- | 0.49 | ---- | ---- | 0.09 | |
| Mud (fresh water) | 40.37 | 1.37 | 0.22 | ---- | ---- | 0.26 | |
| Peat | 61.50 | 0.75 | ---- | ---- | ---- | ---- | |
| Soot | 5.54 | ---- | 1.83 | ---- | ---- | ---- | |
| Turf | 19.29 | 1.94 | ---- | ---- | ---- | ---- | |

### COMPILATION OF ANALYSES OF FERTILIZING MATERIALS IN FARM PRODUCTS.

| Name of Substance. | Moisture. | Nitrogen. | Potash. | Phosphoric Acid. | Valuation per ton of 2,000 lbs. |
|---|---|---|---|---|---|
| *A. Farm Manures.* | | | | | |
| Cattle (solid fresh excrement) | ---- | 0.29 | 0.10 | 0.17 | $ 1.22 |
| Cattle (fresh urine) | ---- | 0.58 | 0.49 | -- -- | 2.35 |
| Hen manure (fresh) | ---- | 1.63 | 0.85 | 1.54 | 7.68 |
| Horse (solid fresh excrement) | ---- | 0.44 | 0.35 | 0.17 | 1.94 |
| Horse (fresh urine) | ---- | 1.55 | 1.50 | -- -- | 6.47 |
| Human excrement (solid) | 77.20 | 1.00 | 0.25 | 1.09 | 4.61 |
| Human urine | 95.90 | 0.60 | 0.20 | 0.17 | 2.33 |
| Poudrette (night soil) | ---- | 0.80 | 0.30 | 1.40 | 4.31 |
| Sheep (solid fresh excrement) | ---- | 0.55 | 0.15 | 0.31 | 2.26 |
| Sheep (fresh urine) | ---- | 1.95 | 2.26 | 0.01 | 8.47 |
| Stable manure (mixed) | 73.27 | 0.50 | 0.60 | 0.30 | 2.49 |
| Swine (solid fresh excrement) | ---- | 0.60 | 0.13 | 0.41 | 2.50 |
| Swine (fresh urine) | ---- | 0.43 | 0.83 | 0.07 | 2.24 |
| *B. Dairy Products.* | | | | | |
| Milk | 87.20 | 0.58 | 0.17 | 0.30 | 2.36 |
| Cream | 68.80 | 0.58 | 0.09 | 0.15 | 2.14 |
| Skim-milk | 90.20 | 0.58 | 0.19 | 0.34 | 2.42 |
| Butter | 13.60 | 0.12 | -- -- | -- -- | 0.40 |
| Butter-milk | 90.10 | 0.64 | 0.09 | 0.15 | 2.34 |
| Cheese (from unskimmed milk) | 38.00 | 4.05 | 0.29 | 0.80 | 14.43 |
| Cheese (from half-skimmed milk) | 39.80 | 4.75 | 0.29 | 0.80 | 16.74 |
| Cheese (from skimmed milk) | 46.00 | 5.45 | 0.21 | 0.80 | 18.95 |
| *C. Flesh of farm animals.* | | | | | |
| Beef | 77.00 | 3.60 | 0.52 | 0.43 | 12.78 |
| Calf (whole animal) | 66.20 | 2.50 | 0.24 | 1.38 | 9.85 |
| Ox | 59.70 | 2.66 | 0.17 | 1.86 | 10.79 |
| Pig | 52.80 | 2.00 | 0.90 | 0.44 | 7.85 |
| Sheep | 59.10 | 2.24 | 0.15 | 1.23 | 8.76 |

## 4. SPECIFIC ACTION OF NITROGEN, PHOSPHORIC ACID AND POTASH UPON PLANT GROWTH.

The effects of abundant supplies of the various deficient elements of plant food are usually shown as follows:

*Nitrogen:*—(a) Stem and leaf growth is favored, sometimes at the expense of perfect bud, flower and fruit development.

(b) The formation of chlorophyll (green coloring matter of the plant) is favored and the color deepened.

(c) The nitrogen in the plant and consequently its feeding value is increased.

*Phosphoric Acid:*—(a) Plant nutrition, particularly in early life, is favored, the mineral ingredients in general being better assimilated.

(b) Fruit and seed development are improved and maturity hastened.

*Potash:*—(a) Woody structure is better developed.

(b) Fleshy parts of fruit are improved in flavor and texture.

(c) The dissemination of starch through the structure of the plant is favored.

## 5. SELECTION, PURCHASE AND USE OF COMMERCIAL FERTILIZERS.

The average buyer of commercial fertilizers purchases on the strength of former personal experience, on the advice of neighbors, or on the representations of agents. He usually buys without definite knowledge of soil or crop needs. Under such circumstances a safe though often costly practice is to buy a so-called "complete" fertilizer furnishing nitrogen, phosphoric acid and potash. If, however, the soil or crop calls for but one or two of these, the third is needlessly bought.

The discriminating buyer should ask himself—

(a) Am I saving all the plant food in my home-made manure?

(b) If so, and I find I need more, shall I buy commercial fertilizers or feed my stock to the limit of healthful production and "fertilize by feeding?"

(c) If I must buy commercial fertilizers what constituents do I need?

(d) In what form shall I buy nitrogen, phosphoric acid and potash for my various crop and soil needs?

(e) Shall I buy complete factory mixed fertilizers, or crude stock and mix it myself?

Assuming (a) and (b) answered in a satisfactory manner and that commercial fertilizers must be bought,

(c) *What constituents are needed?*

Many farmers think that *soil analysis* will disclose soil needs. This belief though natural, is erroneous. Soil analysis fails for the following reasons:

(1) No chemical solvent yet discovered can distinguish between available and insoluble soil ingredients. The chemist's acids dissolve both alike, while water on the other hand does not extract all that soil and root acids take up.

(2) The character of the soil differs so widely even within a few feet as to render it difficult to take representative samples.

(3) Past manuring, location of former manure heaps, etc., often make results obtained misleading.

Since soil analysis does not help, will the analysis of the crop be of use? Many lay much stress upon plant analysis. The formulas of at least one make of special fertilizers sold largely in Vermont are based upon the analyses of the crops they are to fertilize. The following table, showing the amounts of nitrogen, phosphoric acid and potash taken from an acre by one average crop of various kinds, may prove useful in this connection.

TABLE SHOWING POUNDS OF THE CONSTITUENTS MENTIONED WITHDRAWN PER ACRE BY AN AVERAGE CROP.

| | Potash. | Phosphoric Acid. | Nitrogen. |
|---|---|---|---|
| Wheat | 58 | 45 | 111 |
| Rye | 76 | 44 | 87 |
| Barley | 62 | 35 | 78 |
| Oats | 96 | 35 | 89 |
| Corn | 174 | 69 | 146 |
| Buckwheat | 17 | 40 | 63 |
| Pea | 69 | 39 | 153 |
| Horse Bean | 169 | 64 | 254 |
| Soja bean | 87 | 62 | 297 |
| Potatoes | 192 | 55 | 119 |
| Sugar beet, beet-root | 200 | 44 | 95 |
| Cattle turnips | 426 | 74 | 187 |
| Carrots | 190 | 65 | 166 |
| Meadow hay | 201 | 53 | 166 |
| Corn, fodder, green | 236 | 66 | 122 |
| Red clover | 29 | 18 | 87 |
| White clover | 58 | 29 | 89 |
| Crimson clover | 57 | 17 | 95 |
| Vetch | 113 | 85 | 149 |
| Rape | 124 | 79 | 154 |
| Hops | 127 | 54 | 200 |
| Tobacco | 148 | 32 | 127 |
| Onions | 96 | 49 | 96 |

This table should be considered as a guide, not an infallible rule, nor as of necessity showing how much fertilizer to use.

The farmer may form some estimate of soil needs by watching his crops. A pale green leaf indicates a probable lack of nitrogen; a failure to form sound, plump, heavy grain indicates a probable lack of phosphoric acid. Plat tests with the different elements of plant food, singly and in combination, are often helpful. With this data in hand one may still find it best to buy a complete fertilizer but will usually purchase with more discrimination.

(d) *The form in which to buy nitrogen, phosphoric acid and potash* either as complete fertilizer or as crude stock depends on various conditions of soil and crop, and upon the especial objects in mind. For rapid effects, use as source of nitrogen, nitrate of soda or sulphate of ammonia, as source of phosphoric acid, use acid phosphate or bone black superphosphate, and for potash, muriate or sulphate of potash. For less rapid but steady growth, use the better forms of organic nitrogen, acid phosphate or Thomas slag. For slower and more lasting effects, use bone or fish scrap (nitrogen and phosphoric acid) or, on soils rich in organic matter, the fine ground South Carolina rock, known to the trade as "floats," and wood ashes (potash). Leather, wool waste and ground phosphate rock should be used only when one is prepared to wait for years for returns.

The use of certain forms of fertilizing ingredients is desirable with some crops. Potatoes, tobacco and sugar beets do better on sulphate of potash than with the muriate, while with peach trees the reverse is true. Relatively insoluble forms of phosphoric acid are desirable in seeding down. Nitrate of soda is particularly adapted to top-dressing wheat and to the tomato.

If a complete fertilizer is bought designed for use on potatoes or tobacco, the buyer should note the form of potash claimed. It is fully as important, however, that he also note whether the station analyses show that the claim is made good. Chlorin is the measure of the muriate present. If there is three-quarters as much chlorin present as potash, there is no sulphate of potash in the goods or else there is sufficient chlorin in the other ingredients to overcome any beneficial effects of the sulphate. It is instructive to compare claims and facts in this matter. Of the 93 brands reported in this bulletin, 74 claim directly or by inference (i. e. using some such terms as equal to or equivalent to sulphate of potash) to contain potash in the form of sulphate. Analysis confirms the claim in 11 brands, but while of 63 brands or 85 per cent. the claim is without foundation in fact.

(e) Practically all the commercial fertilizers bought in this State consist of so called "complete" goods factory mixed. In States further south, particularly those engaged more largely in market gardening (Rhode Island, Connecticut, New Jersey) the practice of "*home mixing*" has come largely into favor.

## HOME MIXING.

Home mixing consists simply of buying the various fertilizing ingredients in the crude stock and mixing them at the farm. The phosphoric acid may be bought in the available form thus obviating the necessity of handling sulphuric acid. These crude stocks are for sale and may be bought as readily as sugar or spices.

The system of home mixing has both advantages and disadvantages and under many conditions is not applicable.

The advantages claimed are :

(1) Reduced cost of fertilizers.

(2) Definite knowledge of the nature of the plant food employed.

(3) Special crop and soil needs may be met by special mixtures.

(4) Indirect education in farm practice.

The disadvantages found are :

(1) Close quotations are seldom given on small lots.

(2) Vermont farmers, largely engaged in dairying, are not heavy buyers of commercial fertilizers.

(3) Farmers may not make as even or fine mixtures as manufacturers can.

The first two of these disadvantages, namely, high quotations and small consumption are caused by circumstances which must frequently prevent the adoption of home mixing.

The third disadvantage is completely answered by the facts as many times determined* that whatever may or can be done by farmer or manufacturer, the farmer *does* make on the average as even and fine mixtures as the manufacturer.

Taking up the advantages in the order stated :

(1) *Reduced cost.* A recent New Jersey† bulletin shows that home mixtures representing 800 tons cost on the average $30.85 per ton, and that the fertilizing ingredients they contained at Station valuations were worth $34.16, or $3.31 which is *10.7 per cent. over cost.* The average manufacturers' mixture made in 1894 sold at the point of consumption for $34.17 aud had a station valuation of but $24.83, or in other words *cost 37.6 per cent more than the valuation.*

It should be noted, too, that the home mixtures were as fine and as evenly mixed as those made at the factories.

The direct comparison of analyses and valuations is instructive. It should be borne in mind that in the case of the home mixtures the items of mixing, bagging and freight are not included as in the case of the manufacturers' mixtures. Fifty-five farmers estimate the first item to cost on the average 75 cents per ton (see page 42).

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* N. J. Expt. Stat. Bul. '93, p. 10, Bul. 102, p. 13.

† N. J. Exp. Stat. Bul. 102 p. 14.

| Average Composition in 1894 of New Jersey | Nitrogen. | Available Phos. Acid. | Insoluble Phos. Acid. | Potash. | Cost per ton. | Station Valuation. | Cost more or less than Valuation. |
|---|---|---|---|---|---|---|---|
| | % | % | % | % | | | |
| Manufacturers' Mixtures.. | 2.87 | 7.37 | 3·03 | 4.94 | $34.17 | $24.41 | -$9.76 |
| Home Mixtures............ | 3.99 | 8.19 | 2.88 | 10.15 | 30.85 | 34.16 | +3.31 |

In what way is this great reduction in cost obtained?

(1) Goods are bought in large lots for cash instead of in small quantities.

(2) Only high grade stock is bought, saving labor in mixing, bagging, selling expenses and freight on useless material.

(3) The expense of mixing, bagging and selling, are eliminated.

(4) Advantages of market fluctuations may be taken, purchases made early in the year and mixtures made during the winter months.

(2) *Definite knowledge of kinds of plant food used.* Each ingredient can be separately examined by the purchaser or the Experiment Station for him, and its nature and quality determined. Leather, shoddy, wool-waste or other inferior materials cannot be palmed off as readily as when disguised by other ingredients in mixed goods.

(3) *Adaptation of formulas to special needs.* The intelligent and observing farmer can better adapt his fertilizers to his crops and soils than the manufacturer who is ignorant of special needs. If it be urged that manufacturers make special brands for special crops, and that their long experience in the trade makes them better fitted to judge in this matter, it may be said in answer that manufacturers differ widely among themselves as to crop requirements as shown in the composition of the so-called "special" fertilizers. For instance, in the present bulletin we find eight brands of corn fertilizers with guarantees ranging from 1.0 to 3.3 per cent. nitrogen, from 7.5 to 9.5 per cent. available phosphoric acid and from 1.5 to 7.5 per cent. potash; and twenty-four brands of potato fertilizers with guarantees ranging from 1.0 to 3.8 per cent. nitrogen, from 4 to 10 per cent. available phosphoric acid and from 1.85 to 9 per cent. potash. The range in each case is wide enough to suit the most fastidious, yet each brand, if we may believe the claims made for it, is mixed especially to supply the special needs of the crop named. It is probable that if by mistake a "potato manure" fertilized a piece of corn, and the potato patch was dressed with a "corn fertilizer" the results would not be materially different. This probability becomes certainty in cases where guarantee and analysis of different brands of the same company show that the goods are identical, or in other words, that they have been shoveled from the same pile. Stencils are cheap and too often a new

stencil, an ink pot and brush made a new brand of fertilizer. A multiplicity of brands is not of necessity an indication of a healthy fertilizer trade. It is probable that the Vermont farmer would be just as well served by a quarter part of the brands now sold in the State as by the ninety or more now on sale.

*The kind, quality and amounts of nitrogen, phosphoric acid and potash in a fertilizer are the measure of its value,* while names and rival claims are of little significance in comparison with this standard. The value of certain proportions of the fertilizing ingredients for certain crops is not as plain, however.

A careful comparison of (1) guarantees, (2) Station analyses and valuations, (3) selling prices, (4) soil and crop conditions, and (5) the market prices of crude stock, is the best course for the buyer to follow. This study being made he can choose the complete fertilizer more intelligently, or if circumstances warrant it can buy crude stock and mix to advantage himself.

(4) *Indirect education.* The indirect educational value of this practice is of much benefit. It promotes inquiry, investigation, study, and leads to more intelligent and more profitable work.

*What is the experience of practical and successful farmers with home mixing?* The New Jersey bulletin already quoted, gives interesting data on this point. It says*: "Many farmers have adopted this method of purchasing their supplies, and their experience, particularly in the making and using of home mixtures, which in many cases now covers a series of years, has been reported to the Station in answer to our inquiries. These farmers, numbering sixty, whose replies were received in time to be included in this bulletin, and representing ten counties, are making farming their business, and are among the most successful in the State. The questions asked covered in the main the following points:

1. The number of years that home mixtures have been used?
2. The amount used yearly?
3. Whether the quantity of fertilizers used was greater or less than when this method was first adopted?
4. Whether they had any difficulty in getting good mechanical condition?
5. The cost of mixing per ton?
6. Whether the results obtained were satisfactory?
7. Whether it pays to buy raw materials and mix at home?
8. The advantages or disadvantages of this method of purchasing fertilizers?

1. Three report having used home mixtures for 20 years; twelve from 10 to 12 years; twenty-three from 5 to 10 years; seventeen from 2 to 5 years; and five, this as their first year.

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*N. J. Exp. Stat. Bul. 102, p. 16-18.

2. Seven farmers use over 25 tons per year—one as high as 40 tons; sixteen use 15 tons or more; fourteen use 10 to 15 tons; sixteen use 5 to 10 tons; and six less than 5 tons.

3. Forty-two of the sixty use more now than when they began ; five, three to four times as much, and eleven about the same quantity, varying according to the area of the best-paying crop.

4. Fifty-four state that they do not have any difficulty in getting good mixtures; four had some difficulty at first, while one states that his home mixtures excel in mechanical condition any manufactured brand he has ever used.

5. Considerable variation is reported in the cost of mixing; two report an expense of $1.50 per ton; fifteen say that it cost $1 per ton; sixteen estimate the cost at 75 cents; nineteen at 50 cents; one at 60 cents; two at 25 cents, and two do not regard the mixing as an extra cost. They all report the mixing as being done by the ordinary labor of the farm, when other work is not pressing, and therefore no extra expenditure.

6. Fifty-four farmers report that the results are thoroughly satisfactory, both in regard to the yield and the quality of crop. Five report this year as their first year, though their crops are looking quite as well as where other brands were used.

7. Fifty-three state that it pays them well to buy raw materials and mix for themselves; five have not yet secured results, and one thinks he can do about as well in buying the regular brands.

8. With two exceptions all agree that the main advantage derived is that the actual constituents cost much less than in the same grade of goods purchased either directly from manufacturers or from dealers. Twenty-six state that the saving is from $6 to $10 per ton, and that further advantages are—

First, that they know exactly what they are using. Second, that they can use the best forms of plant-food. Third, that the essential constituents can be varied to suit the requirements of various soils and crops.

One farmer reports that the third point alone has been of the greatest service to him, enabling him to make profitable, crops which were formerly considered almost impossible to raise.

But three farmers report any disadvantage. One states that there is considerable loss from handling; another that it is difficult to procure the materials in small quantities at a reasonable price, while a third considers it a disadvantage to pay cash.

The above summary of the practical experience of farmers is, perhaps, sufficient evidence of the value of home-mixing, and the strongest argument that could be presented for the adoption of this method of purchasing supplies.

The main conditions to be observed, and which are necessary, in order to make the methód entirely feasible and truly economical, are—

first, that the supplies should be purchased in considerable quantities; second, that they should be purchased early, and prepared before the beginning of the busy season on the farm; third, that contracts should be on a cash basis."

*How is Home Mixing done?* A tight barn floor, platform scales, screen, shovel and hoe, are the only utensils needed. The materials being weighed, screened, and lumps pulverized, the most bulky stock is spread in an oblong pile from 6 to 12 inches deep; upon its leveled top the next material is placed, and so on until all have been added like layers on a layer cake. Commencing at one end the pile is shoveled over, reaching clear to the bottom every time. The pile is then leveled up and the operation repeated three times. The mixture may then be screened again if desired.

*Is Home Mixing adapted to Vermont farm conditions?* Our farmers seldom use large quantities of commercial fertilizers, but farmers' clubs, granges, etc., might find it advantageous to buy crude stock in car load lots and mix to suit individual needs.

The following[*] is a form, taken with slight changes, from a circular sent to dealers in fertilizing chemicals by a New Jersey grange, which may prove suggestive to any contemplating home mixing in this State:

> "Wanted: To buy the materials to make ——— tons or more of fertilizer. The materials to consist of nitrate of soda, sulphate of ammonia, acid phosphate, dissolved bone or bone black, fine ground bone, fine ground fish scrap, muriate of potash and sulphate of potash. All materials to be in good mechanical condition; in good bags; to run even weights or be plainly marked what each bag contains net, and to be delivered at ———early in March next. All materials to be guaranteed to contain certain percentages of nitrogen, potash or available phosphoric acid, as the case may be; one-half of the bill to be paid within ten days after receipt of goods; on the other half a credit of sixty days to be allowed, within which time samples will be sent to the Vermont Experiment Station for analysis, and if there found to contain as large percentages as guaranteed the balance of the bill will be paid within the sixty days, but if any are found to contain a less percentage than guaranteed, then a discount is to be allowed on the bill equal to the loss in money value caused by such deficiency for the first one per cent or fraction thereof, and twice the loss in money value for all deficiencies in excess of one per cent, and balance of bill within the sixty days. Samples to be taken by a station agent or other disinterested party."[†]

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[*] From Conn. Expt. Stat. Rpt. 1888, p. 71.

[†] The so-called "unit system" will be found a satisfactory method of purchase on guarantee. A unit means 1 per cent on the basis of a ton and is 20 pounds. A material containing, for example, 14 per cent available phosphoric acid is said to contain fourteen units of phosphoric acid to the ton, or 280 pounds. Such a material sold on guarantee at, say, $1.20 per unit and analyzing 14 per cent would be worth 14x1.20 or $16.80 a ton; if it analyzed but 13 per cent, 13x1.20 or $15.60 only would be due. This is the method by which manufacturers buy and sell crude stock, and it is to be hoped that in time it will become the general rule in the sale of mixed goods. It is also to be hoped that the day of high flown names and claims is nearly done. Dr. Charles W. Dabney, Assistant Secretary of Agriculture in a recent number of the American Fertilizer (November, 1894), suggests a rational system of fertilizer manufacture. He proposes a basal mixture of certain per cent of nitrogen, phosphoric acid and potash to which for special crops and needs definite amounts of definite kinds of crude stock may be added.

The following formulas were prepared by practical farmers in Connecticut* and New Jersey† for home mixing and have as a rule given satisfaction. They should not be blindly followed, but may prove helpful. It is doubtful if as much nitrogen as is found in some of these mixtures is needed when there is a fair supply of barn yard manure.

FOR GENERAL USES.

665 pounds Tankage.
667 pounds Dissolved Bone Black.
(1) 167 pounds Bone
167 pounds Sulphate of Ammonia.
167 pounds Double Sulphate of Potash.
2000

175 pounds Muriate of Potash.
850 pounds Dissolved Bone Black
(2) 125 pounds Tankage.
175 pounds Sulphate of Ammonia.
125 pounds Bone
550 pounds Fish containing some Potash.
2000

200 pounds Nitrate of Soda.
200 pounds Sulphate of Ammonia.
400 pounds Bone.
(3) 400 pounds Bone Black Superphos.
600 pounds S. C. Rock Superphos.
200 pounds Muriate of Potash.
2000

FOR POTATOES.

250 pounds Nitrate of Soda.
200 pounds Sulphate of Ammonia.
(4) 400 pounds Tankage.
700 pounds Bone Black Superphos.
450 pounds High Grade Sulphate of Potash.
2000

100 pounds Nitrate of Soda.
400 pounds Dissolved Bone.
(5) 400 pounds Bone.
700 pounds Bone Black Superphos.
400 pounds High Grade Sulphate of Potash.
2000

450 pounds Tankage.
170 pounds Sulphate of Ammonia.
(6) 1000 pounds Dissolved Bone Black.
280 pounds Muriate of Potash.
100 pounds Double Sulphate of Potash.
2000

FOR CORN.

500 pounds Bone.
(7) 200 pounds Muriate of Potash.
600 pounds Dissolved Bone Black.
500 pounds Tankage.
200 pounds Nitrate of Soda.

The following from Bulletin 6, Md. Expt. Station may prove of use.

COMPLETE HIGH GRADE.

700 pounds Dissolved Bone Black.
500 pounds Dissolved Bone.
200 pounds Dried Blood.
(8) 200 pounds Nitrate of Soda.
100 pounds Sulphate of Ammonia.
200 pounds Muriate of Potash
100 pounds Sulphate of Potash.
2000 pounds.

COMPLETE MEDIUM GRADE.

1200 pounds Dissolved Bone Black.
500 pounds Tankage.
(9) 100 pounds Nitrate of Soda.
200 pounds Muriate of Potash.
2000 pounds.

1700 pounds Dissolved Bone Black.
(12) 100 pounds Nitrate of Soda.
200 pounds Dried Fish.
2000

1800 pounds Dissolved S. C. Rock.
100 pounds Nitrate of Soda.
(13) 100 pounds Sulphate of Ammonia.

COMPLETE HIGH IN PHOS. ACID.

500 pounds Keystone Conc. Phos.
(14) 600 pounds Dissolved S. C. Rock.
500 pounds Dissolved Bone.
100 pounds Dried Fish.
100 pounds Tankage.
200 pounds Cotton Seed Hull Ash.
2000 pounds.

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*Conn. Expt. Stat. Rpt. 1891, p. 76-78.

†N. J. Expt. Stat. Rpt. for 1892, p. 39.

COMPLETE LOWER GRADE.

(10)
1600 pounds Dissolved S. C. Rock.
150 pounds Dried Ground Fish.
100 pounds Nitrate of Soda.
150 pounds Muriate of Potash.
2000 pounds.

AMMONIATED SUPERPHOSPHATES WITHOUT POTASH.

(11)
1300 pounds Dissolved Bone.
200 pounds Nitrate of Soda.
200 pounds Sulphate of Ammonia.
100 pounds Dried Blood.
200 pounds Dried Fish.
2000 pounds.

SUPERPHOSPHATE WITH MUCH POTASH.

(15)
1300 pounds Dissolved S. C. Rock.
500 pounds Cotton Seed Hull Ash.
200 pounds Muriate of Potash.
2000 pounds.

SUPERPHOSPHATES.

(16)
600 pounds Keystone Conc. Phos.
700 pounds Dissolved Bone Black.
700 pounds Dissolved S. C. Rock.
2000 pounds.

(17)
1200 pounds Dissolved S. C. Rock.
800 pounds Thomas slag.
2000 pounds.

These formulas analyse as follows (first seven, actual analyses, last ten, calculated). They do not suffer in comparison with factory mixed goods.

TABLE OF ANALYSES OF GOODS MADE ACCORDING TO FORMULAS.

| | NITROGEN. | | | | PHOSPHORIC ACID. | | | | | POTASH. |
|---|---|---|---|---|---|---|---|---|---|---|
| | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total. | Soluble. | Reverted. | Insoluble. | Total. | Available. | |
| 1 | ----- | 1.64 | 2.32 | 3.96 | 7.02 | 3.16 | 2.34 | 12.52 | 10.18 | 6.35 |
| 2 | ----- | 1.97 | 1.61 | 3.58 | 7.95 | 1.77 | 0.55 | 10.27 | 9.72 | 5.42 |
| 3 | 1.72 | 1.98 | 0.28 | 3.98 | 7.90 | 3.76 | 2.32 | 13.98 | 11.66 | 5.11 |
| 4 | 1.42 | 2.13 | 1.59 | 5.14 | 5.80 | 0.27 | 0.33 | 6.40 | 6.07 | 13.23 |
| 5 | 0.67 | ----- | 1.22 | 1.89 | 7.80 | 3.51 | 3.31 | 14.62 | 11.31 | 10.79 |
| 6 | ----- | 1.60 | 1.63 | 3.23 | 10.25 | 1.53 | 0.56 | 12.34 | 11.78 | 6.53 |
| 7 | 1.45 | ----- | 2.78 | 4.23 | 5.60 | 4.72 | 4.14 | 14.46 | 10.32 | 5.32 |
| 8 | 1.58 | 1.08 | 1.60 | 4.30 | ------ | ------ | 1.15 | 10.35 | 9.20 | 7.04 |
| 9 | 0.79 | ---- | 1.77 | 2.56 | ------ | ------ | 1.80 | 12.86 | 11.06 | 5.24 |
| 10 | 0.79 | ---- | 0.53 | 1.32 | ------ | ------ | 3.83 | 12.78 | 8.95 | 3.98 |
| 11 | 1.58 | 2.05 | 2.92 | 6.55 | .. -- | ------ | 3.07 | 12.26 | 9.19 | ------ |
| 12 | 0.79 | ----- | 0.70 | 1.49 | ------ | ------ | 0.60 | 15.27 | 14.67 | ------ |
| 13 | 0.79 | ---- | 1.02 | 1.81 | ------ | ------ | 3.42 | 13.68 | 10.26 | ------ |
| 14 | ----- | ----- | 1.35 | 1.35 | ------ | ------ | 5.47 | 20.27 | 14.80 | 2.04 |
| 15 | ----- | ----- | ----- | ----- | ------ | ------ | 4.35 | 11.76 | 7.41 | 10.48 |
| 16 | ----- | ----- | ----- | ----- | ------ | ------ | 3.88 | 22.82 | 18.94 | ------ |
| 17 | ----- | ----- | ----- | ----- | ------ | ------ | 8.30 | 17.66 | 9.36 | ------ |

The Experiment Station stands ready to aid with advice and analysis all who desire to try home mixing.

It should be noted that purchasers of unmixed chemicals for personal use do not violate the State fertilizer law which does "not affect parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in this State."

## 6. EXPLANATION OF TERMS USED IN FERTILIZER GUARANTEES AND ANALYSES.

The State law requires that fertilizers sold in Vermont "shall be accompanied by a chemical analysis stating percentage of nitrogen or its equivalent in ammonia, of potash, soluble in distilled water, and of phosphoric acid in available form, soluble in distilled water and reverted as well as the total phosphoric acid." Some of the goods sold in the State comply in the matter of guarantees with both the letter and the spirit of the law, while many comply with the spirit only. All sorts of guarantees are found. Nitrogen is expressed as (1) nitrogen, (2) nitrogen equal to ammonia or nitrogen equivalent to ammonia or (3) ammonia. The phosphoric acids are expressed as (1) soluble, (2) soluble and available, (3) available, (4) sometimes as total only and often also as (5) Bone Phosphate of Lime. Potash is expressed as (1) potash, (2) potash as sulphate, (3) potash equal to sulphate or potash equivalent to sulphate, (4) potash-sulphate or sulphate of potash. In general it may be said that terms other than those required by law are used principally to make a show of giving larger amounts of plant food than are actually present. For instance a common guarantee is "Nitrogen equivalent to Ammonia 2.5 per cent." This is not a guarantee of 2.5 per cent. of nitrogen but of sufficient nitrogen to form 2.5 per cent. ammonia or 2.06 per cent. nitrogen (since but 82.3 per cent. of ammonia is nitrogen). The large amounts of Bone Phosphate of Lime frequently seen in guarantees add nothing to the value of the goods, being but the calculation of the total phosphoric acid into its combined form of tri-calcic phosphate. (see p. 29) The terms potash-sulphate, potash as sulphate, potash equal to or equivalent to sulphate, sometimes mean one thing (potash) and sometimes another (potassium sulphate of which but 54 per cent. is actual potash). It is well to bear these points in mind in interpreting guarantees.

The figures in the tables of analyses of licensed fertilizers show the per cents or parts per hundred found.

Column 1, per cent. of nitrogen derived from nitrate of soda.
" 2, per cent. of nitrogen derived from sulphate of ammonia.
" 3, per cent. of nitrogen derived from organic matter.
" 4, per cent. of total nitrogen, being columns 1, 2 and 3 added.

Column 7, per cent. of phosphoric acid soluble in water.
" 8, per cent. of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under specified conditions and soluble in plant and root acids.
" 9, per cent. of phosphoric acid insoluble in water or ammonium citrate, and but slowly available for plant uses.
" 10, per cent. of total phosphoric acid, being columns 7, 8 and 9 added.
" 12, per cent. of phosphoric acid readily available to the plant, being columns 7 and 8 added.
" 15, per cent. of potash soluble in water.
" 18, per cent. of chlorin which indicates the form in which the potash is present.

Columns 5, 11, 13, and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the money value of the nitrogen, phosphoric acid and potash found in the various forms present in the fertilizer. the same being based on a careful study of the prices ruling in the leading markets of the better forms of crude stock.

The question is often asked why the plant food contained in a fertilizer does not add up to 100. For instance the average Vermont goods this year contain in a hundred, 2.22 pounds nitrogen, 10.93 pounds total phosphoric acid and 3.46 pounds of potash, a total of 16.61 pounds. Of what did the other 83.39 pounds consist and is it needed for plant growth? It will be remembered that nitrogen is a gas, and phosphoric acid and potash respectively strong acid and alkali, and that they can only be useful in combined forms. If medium grade materials were used in the manufacture of the average fertilizer* as stated above it might be made up about as follows:

| | | |
|---|---|---|
| 440 | pounds | of organic matter (blood, tankage, etc.) |
| 850 | " | of ground S. C. rock and sulphuric acid. |
| 110 | " | of muriate of potash. |
| 1400 | | |

This would leave 600 pounds or 30 per cent. of the gross weight in every ton, for moisture, dirt and useless material on which freight, mixing

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*A complete analysis would probably resemble the following:

| | | |
|---|---|---|
| Water | 16. | (combined with organic matter and sulphuric acid.) |
| Nitrogen | 2.2 | |
| Phosphoric Acid | 10.6 | |
| Potash | 2.9 | |
| Volatile and Organic | 33.0 | (combined with nitrogen.) |
| Gypsum | 16. | (formed by action of sulphuric acid on rock.) |
| Lime | 7.1 | (left combined with phosphoric acid,) |
| Sand | 4. | (impurity in phosphate rock.) |
| Chlorin and Salts | 3. | (combined with potash.) |
| Miscellaneous | 5.2 | |
| | 100.0 | |

and bagging expenses, storage, etc., must be paid by the consumer. It is plain then that the average fertilizer sold in this State as in others, is made either of low grade materials or has useless make-weight material added. This condition is not the fault of the manufacturers alone for there is a large demand for cheap goods. Such however are often the most costly, since it costs as much to mix, bag, freight and sell dirt as fertility. Estimating the fertilizer trade of the State at 6000 tons, and assuming that medium grade materials are used, there are 6000x30=1800 tons of materials containing no plant food mixed, bagged, shipped and sold to Vermont consumers yearly. If the comparison is made between plant food in home mixtures and that in manufactured goods the amount of useless material sold is even larger than by the other calculation.

### HOW TO CALCULATE A STATION VALUATION.

The schedule of trade values to be used in this State in 1895 was printed in Bulletin 45 with an explanation of its application to superphosphates and mixed goods. So far as they apply to mixed goods they are

Nitrogen in ammonia salts 18½ cts. per pound.
Nitrogen in nitrates 15 cts. per pound.
Organic nitrogen in mixed fertilizers 16½ cts. per pound.
Phosphoric acid soluble in water 6 cts. per pound.
Phosphoric acid soluble in ammonium citrate 5½ cts. per pound.
Phosphoric acid insoluble in mixed fertilizers 2 cts. per pound.
Potash as high grade sulphate or in mixed fertilizers free from muriate or chlorid 5½ cts per pound.
Potash as muriate 4½ cts. per pound.

**The Station valuation of a brand of fertilizer does not represent the proper selling price at the point of consumption,** but shows the retail cash prices of the various fertilizing ingredients in the large markets, unmixed but ready for use. It does not include freight, cost of manufacture, storage, commissions, etc. It stands in no necessary relation to the profits derived from the use of the goods, but has an almost purely commercial significance. For further information regarding trade values see Bulletin 45.

To determine a Station valuation from analysis or guarantee, multiply per cent. of each ingredient (which is equivalent to pounds per hundred) by 20 to find pounds per ton; then multiply result obtained by the trade value as given above; add results for Station valuation per ton. In calculating valuations from guarantees it should be noted that the lower figure given is all the seller is bound to deliver. For instance, 2 to 4 per cent. potash guarantees 2 per cent. only.

To reduce ammonia to nitrogen, multiply per cent. given by .82; to reduce sulphate of potash to potash, multiply per cent. given by .54.

## III ANALYSES OF LICENSED FERTILIZERS.

Sixteen firms are licensed to sell commercial fertilizers in Vermont (see list Bul. 45. p. 8.). Ninety-two distinct brands, the output of these firms have been sampled and analysed. The results obtained on fifteen brands were published in Bulletin 45 and on thirty-three brands in Bulletin 46. A portion of the former and all the latter are reprinted in this bulletin so that analyses of all brands sampled this year will be found on the succeeding pages. It is believed that all but two brands sold in the State this spring have been sampled and analysed.

Sixty of the ninety-two brands inspected were found up to the manufacturers minimum guarantees, in nitrogen, available phosphoric acid and potash ; twenty-six were 0.10 per cent. or more below guarantee in one of the three ingredients ; nine were below 0.10 per cent. or more in two of of these ingredients. There was no brand below guarantee throughout. Twenty-nine of the brands found deficient were imperfectly mixed at the factory and contained excess of one or more ingredients to counterbalance the shortage, thus affording a money equivalent. It is safe to say, that ninety-five per cent. of the brands sold in Vermont in 1895 contained the commercial equivalent of their guarantees.

## LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1550 | Corn Phosphate | Bowker Fertilizer Co., Boston, Mass | L. F. Fortney, Plainfield<br>G. E. Pringle, East Charlotte | 1550 |
| 1370 | Fish and Potash | " " " | C. G. & H. F. Leach, North Rupert | 1370 |
| 1371 | Grain and Fodder Corn | " " " | C. G. & H. F. Leach, North Rupert | 1370 |
| 1348 | Potato and Vegetable Manure | " " " | L. F. Fortney, Plainfield | 1348 |
| 1538 | Potato Phosphate | " " " | A. C. Davis, Norwich<br>G. E. Pringle, East Charlotte | 1538 |
| 1551 | Square Brand Bone and Potash | " " " | P. B. B. Northrop, Sheldon | 1551 |
| 1536 | Stockbridge Manure for Corn | " " " | A. C. Davis, Norwich<br>A. E. Fuller, Woodstock | 1536 |
| 1535 | Stockbridge Manure for Seed'g Down | " " " | C. G. & H. F. Leach, No. Rupert<br>A. E. Fuller, Woodstock | 1535 |
| 1422 | Stockbridge Manure for Strawberries | " " " | G. E. Pringle, East Charlotte | 1422 |
| 1534 | Stockbridge Manure for Top Dressing | " " " | L. F. Fortney, Plainfield<br>D. C. Wright, Westminster | 1534 |
| 1537 | Sure Crop Phosphate | " " " | A. C. Davis, Norwich<br>A. E. Fuller, Woodstock | 1537 |
| 1411 | Superphosphate with Potash | " " " | Rumsey & St. John, Castleton | 1411 |
| 1421 | Ten Per Cent. Manure | " " " | G. E. Pringle, East Charlotte | 1421 |
| 1539 | B. D. Sea Fowl Guano | Bradley Fertilizer Co., Boston, Mass | Ira W. Thorp, Underhill<br>A. P. Fish, West Randolph | 1539 |
| 1552 | Complete Potato and Vegetable | " " " | I. T. Huntley, Westford | 1552 |
| 1417 | Complete, Top Dressing, etc | " " " | L. W. Loukes, Vergennes | 1417 |
| 1221 | Ground Bone and Potash | " " " | G. H. Kay, Walden | 1221 |
| 1345 | Seeding Down Manure | " " " | C. H. Higgins, Passumpsic | 1345 |
| 1276 | Bay State Fertilizer, G. G | Clark's Cove Guano Co., Boston, Mass. | W. B. D. Avery, Bradford | 1276 |
| 1277 | Potato and Tobacco Fertilizer | " " " | W. B. D. Avery, Bradford | 1277 |

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1550 | Bowker's Corn Phosphate | 0.49 | ---- | 1.32 | 1.81 | 1.5 | $5.83 | 3.99 | 3.62 | 5.89 | 13.50 | 11. | 7.61 | 9. | $11.13 | 1.98 | 2. | $1.78 | 1.70 | 1550 |
| 1370 | " Fish and Potash | 0.43 | ---- | 0.67 | 1.10 | 0.75 | 3.50 | 4.97 | 2.19 | 6.59 | 13.75 | 9. | 7.16 | 6. | 11.01 | 1.02 | 1. | 0.92 | 2.47 | 1370 |
| 1371 | " Grain and Fodder Corn | 1.16 | ---- | 2.08 | 3 24 | 3.25 | 10.34 | 7.99 | 2.19 | 2.36 | 12.54 | 10. | 10.18 | 8. | 12.94 | 4.57 | 4.25 | 4.11 | 4.40 | 1371 |
| 1348 | " Potato and Vegetable | 0.55 | 0.23 | 1.89 | 2.67 | 2.5 | 8.74 | 7.21 | 2.06 | 2.89 | 12.16 | 10. | 9.27 | 8. | 12.07 | 4.94 | 4. | 4.45 | 5.61 | 1348 |
| 1538 | " Potato Phosphate | 0.46 | ---- | 1.43 | 1.89 | 1.5 | 6.10 | 5.52 | 2.88 | 4.43 | 12.83 | 10. | 8.40 | 8. | 11.56 | 2.21 | 2. | 1.99 | 3.05 | 1538 |
| 1551 | " Sqr. Br. Bone & Potash | ---- | ---- | 1.69 | 1.69 | 1.64 | 5.58 | 1.95 | 5.20 | 9.65 | 16.80 | 12. | 7.15 | 6. | 11.92 | 3.23 | 2. | 2.91 | 5.23 | 1551 |
| 1536 | " Stockbridge for Corn | 1.25 | ---- | 2.11 | 3.36 | 3.25 | 10.71 | 7.70 | 2.33 | 2.50 | 12.53 | 10. | 10.03 | 8. | 12.80 | 4.80 | 4. | 4.32 | 4.56 | 1536 |
| 1535 | " " for Seed'g Down | 1.07 | ---- | 1.43 | 2.50 | 2 5 | 7.93 | 5.42 | 1.91 | 4.82 | 12.15 | 12. | 7.33 | 6. | 10.53 | 10.89 | 10. | 9.80 | 10.77 | 1535 |
| 1422 | " " for Strawberries | 0.77 | ---- | 1.84 | 2.61 | 2.5 | 8.38 | 7.14 | 2.95 | 3.87 | 13.96 | 7. | 10.09 | 6. | 13.36 | 4.27 | 4. | 4.40 | 0.44 | 1422 |
| 1534 | " " for Top Dressing | 2.20 | ---- | 3.18 | 5.38 | 5. | 17.09 | 3.78 | 1.79 | 3.33 | 8.90 | 6. | 5.57 | 4. | 7.84 | 6.34 | 6. | 5.71 | 6.53 | 1534 |
| 1537 | " Sure Crop Phosphate | 0.29 | ---- | 0.87 | 1.16 | 0.75 | 3.74 | 2.38 | 4.99 | 6.04 | 13.41 | 10. | 7.37 | 8. | 10.76 | 1.14 | 1. | 1.03 | 1.72 | 1537 |
| 1411 | " Superphos, with Potash | ---- | ---- | ---- | ---- | ---- | ---- | 2.98 | 6.31 | 3.28 | 12.57 | 12. | 9.29 | 10. | 11.83 | 1.89 | 1. | 1.70 | 1.86 | 1411 |
| 1421 | " Ten Per Cent Manure | 0.44 | ---- | 0.77 | 1.21 | 0.82 | 3.86 | 0.60 | 3.29 | 6.46 | 10.35 | 8. | 3.89 | 6. | 8.00 | 10.53 | 10. | 9.47 | 10.09 | 1421 |
| 1539 | Bradley's B. D. Sea Fowl Guano | ---- | ---- | 2.16 | 2.16 | 2.05 | 7.13 | 6.98 | 2.59 | 1.79 | 11.36 | 10. | 9.57 | 8. | 11.94 | 2.12 | 1.5 | 1.91 | 2.42 | 1539 |
| 1552 | " Complete Potato & Veg. | 0.85 | 0.11 | 2.52 | 3.48 | 3.7 | 11.27 | 4.84 | 3.69 | 2.78 | 11.31 | 9. | 8.53 | 8. | 10.98 | 5.77 | 6. | 5.19 | 6.56 | 1552 |
| 1417 | " " Top Dress'g, etc. | 2.44 | ---- | 2.65 | 5.09 | 4.95 | 16.07 | 1.40 | 3.76 | 1.54 | 6.70 | 6. | 5.16 | 5. | 6.43 | 3.70 | 2.5 | 3.33 | 3.53 | 1417 |
| 1221 | " Ground Bone & Potash | 0.69 | ---- | 1.75 | 2.44 | 1.85 | 7.85 | 4.09 | 1.64 | 6.10 | 11.83 | 8. | 5.73 | | 9.15 | 2.80 | 2. | 2.84 | 0.52 | 1221 |
| 1345 | " Seeding Down Manure | 0.34 | 0.12 | 2.41 | 2.89 | 2.5 | 9.42 | 6.85 | 2.37 | 1.69 | 10.91 | 12. | 9.22 | 7. | 11.51 | 2.45 | 2. | 2.20 | 2.98 | 1345 |
| *1276 | ClarksCove Bay State Fert. G. G. | ---- | ---- | 2.28 | 2.28 | 1.85 | 7.52 | 7.22 | 1.59 | 1.19 | 10.00 | 10. | 8.81 | 8.5 | 10.89 | 2.70 | 2. | 2.43 | 3.92 | 1276 |
| 1277 | " Potato and Tobacco | ---- | ---- | 2.16 | 2.16 | 2.05 | 7.13 | 4.85 | 3.26 | 3.17 | 11.28 | 9. | 8.11 | 8. | 10.67 | 3.37 | 3. | 3.03 | 4.91 | 1277 |

*Reprinted from Bulletin 45.

## LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1540 | Superphosphate | Cleveland Dryer Co., Cleveland, Ohio | C. R. Lane, Cornwall<br>A. P. Fish, West Randolph | 1540 |
| 1542 | Celebrated Special Potato Fertilizer | E. Frank Coe Co., New York, N. Y. | Brown & Skinner, Barton Ln'dg<br>J. H. George. St. Johnsbury | 1548 |
| 1548 | Columbian Ammoniated Bone | " " " | Barrows & Peck, Montpelier<br>Farnsworth & Co., Middlebury | 1541 |
| 1541 | Excelsior Potato Phosphate | " " " | M. Burbank, Irasburgh<br>Silas Giddings, Castleton | 1389<br>1239 |
| 1389 | Gold Brand Excelsior Guano | " " " | Silas Giddings, Castleton | 1233 |
| 1239 | High Grade Ammo. Bone Superphos. | " " " | Brown & Skinner, Barton Landing | 1553 |
| 1233 | High Grade Potato Phosphate | " " " | M. Burbank, Irasburgh | 1542 |
| 1553 | Red Brand Excelsior Guano | " " " | H. L. Page, Essex | |
| 1209 | Fertilizer | Cumberland Bone Phos.Co.,Portland,Me. | W. H. Nye, Johnson | 1209 |
| 1220 | Seeding-down Fertilizer | " " " | A. M. Foster, Cabot | 1220 |
| 1273 | Grain and Grass Fertilizer | Great Eastern Fertilizer Co., Rutland, Vt. | A. N. Johnson, West Brattleboro | 1273 |
| 1242 | Grass and Oats Fertilizer | " " " | Josiah Grout, Derby | 1242 |
| 1272 | Oats, Buckwheat and Seeding Down | " " " | A. N. Johnson, West Brattleboro | 1272 |
| 1275 | Soluble Bone and Potash | " " " | A. N. Johnson, West Brattleboro | 1275 |
| 1543 | Vegetable Vine and Tobacco Fertil'r | " " " | J. H. Hicks, Manchester<br>A. N. Johnson, West Brattleboro | 1543 |
| 1382 | Wheat Special | " " " | J. H. Hicks Manchester | 1382 |
| 1544 | Animal Bone and Potash | Lister's Agl.Chem. Works, Newark,N. J. | Chas. Chandler, Chester<br>R. J. Marranville, Wallingford | 1544 |
| 1554 | Complete Potato Manure | " " " | M. V. Leach, Essex | 1554 |
| 1403 | Corn Manure | " " " | N. B. Denio, Pawlet | 1403 |
| 1545 | Potato Fertilizer No. 2 | " " " | A. E. Ellis, Richmond<br>S. W. Bates, Springfield<br>Chas. Chandler, Chester | 1545 |

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1540 | Cleveland Superphosphate | - - | 0.11 | 2.15 | 2.26 | 2.05 | $7.51 | 6.88 | 2.37 | 1.25 | 10.50 | 11 | 9.25 | 9 | $11.36 | 2.52 | 2 | $2.27 | 2.81 | 1540 |
| 1542 | Coe's Celebrated Special Potato | - - | - - | 2.05 | 2.05 | 1.65 | 6.77 | 7.77 | 2.33 | 2.00 | 12.10 | 11 | 10.16 | 9 | 12.69 | 3.24 | 3.5 | 3.37 | 0.14 | 1542 |
| 1548 | " Columbian Ammo. Bone | - - | 0.13 | 1.69 | 1.82 | 1. | 6.06 | 7.22 | 1.98 | 3.34 | 12.54 | 11 | 9.20 | 9 | 12.18 | 1.90 | 1.85 | 1.94 | 0.28 | 1548 |
| †1541 | " Excelsior Potato Fertilizer | - - | 0.38 | 2.42 | 2.80 | 3.3 | 9.40 | 5.97 | 1.09 | 0.94 | 8.01 | | 7.07 | 7 | 8.74 | 8.70 | 9 | 9.11 | 0.14 | 1541 |
| 1389 | " Gold Brand Excelsior Guano | - - | 0.80 | 1.78 | 2.58 | 2.5 | 8.83 | 6.79 | 1.68 | 2.65 | 11.12 | 9 | 8.47 | 8 | 11.06 | 5.24 | 6 | 5.40 | 0 55 | 1389 |
| *1239 | " High Grade Ammo. Bone | - - | 0.14 | 2.02 | 2.16 | 2. | 7.19 | 7.45 | 1.85 | 2.59 | 11.89 | 11 | 9.30 | 9 | 12.02 | 1.87 | 1.85 | 1.89 | 0.38 | 1239 |
| 1233 | " High Grade Potato Fertilizer | - - | 0.31 | 2.00 | 2.31 | 2.05 | 7.75 | 6.40 | 1.65 | 2.60 | 10.65 | 9 | 8.05 | 8 | 10.53 | 5.02 | 6 | 5.20 | 0.39 | 1233 |
| 1553 | " Red Brand Excelsior Guano | - - | 0.46 | 2.92 | 3.38 | 3.5 | 11.34 | 6.36 | 1.49 | 1.25 | 9 10 | 10 | 7.85 | 9 | 9.77 | 6.16 | 5.94 | 6.36 | 0.52 | 1553 |
| *1209 | Cumberland Fertilizer | - - | - - | 1.30 | 1.30 | 1.03 | 4.29 | 6.03 | 1.66 | 1.40 | 9.09 | 10 | 7.69 | 8 | 9.63 | 2.59 | 2.6 | 2.33 | 2.84 | 1209 |
| 1220 | " Seeding Down Fertilizer | - - | - - | 1.42 | 1.42 | 1.23 | 4.69 | 5.54 | 2.53 | 1.96 | 10.03 | 12 | 8.07 | 8 | 10.22 | 2.47 | 2 | 2.22 | 3.50 | 1220 |
| 1273 | Great Eastern Grain and Grass | 0.32 | 0.11 | 2.46 | 2.89 | 2.47 | 9.49 | 6.86 | 1.10 | 1.13 | 9.09 | 9 | 7.96 | 8 | 9.89 | 2.38 | 2 | 2.14 | 4.15 | 1273 |
| 1242 | " " Grass and Oats | - - | - - | - - | - - | - - | - - | 8.61 | 3.23 | 2.38 | 14.22 | | 11.84 | 11 | 14.85 | 1.57 | 2 | 1.41 | 1.56 | 1241 |
| 1272 | " " Oats and Seed Down | 0.17 | - - | 1.03 | 1.20 | 0.82 | 3.91 | 6.44 | 1.15 | 0.94 | 8.53 | 9 | 7.59 | 8 | 9.37 | 3.86 | 4 | 3.47 | 4.25 | 1272 |
| ‡1275 | " " Soluble Bone & Potash | - - | - - | - - | - - | - - | - - | 6.58 | 1.62 | 2.00 | 10.20 | | 8.20 | 10 | 10.48 | 2.49 | 4 | 2.24 | 5.32 | 1275 |
| 1543 | " " Vegetable Vine &Tob. | 0.27 | 0.11 | 1.71 | 2.09 | 2.05 | 6.86 | 4.00 | 4.43 | 0.83 | 9.26 | 9 | 8.43 | 8 | 10.00 | 4.41 | 3.25 | 3.97 | 5.69 | 1543 |
| 1382 | " " Wheat Special | - - | 0.21 | 1.48 | 1.69 | 1.64 | 5.66 | 1.47 | 7.31 | 1.50 | 10.28 | 9 | 8.78 | 8 | 10.41 | 2.18 | 2 | 1.96 | 3.02 | 1382 |
| 1544 | Lister's Animal Bone and Potash | - - | - - | - - | - - | - - | - - | 7.00 | 2.22 | 0.67 | 9.89 | 10 | 9.22 | 9 | 11.11 | 4.99 | 5 | 4.49 | 4.95 | 1544 |
| 1554 | " Potato Manure | - - | - - | - - | 3.72 | 3.7 | 12.28 | 6.32 | 1.64 | 1.38 | 9.34 | | 7.96 | 7.5 | 9.94 | 7.52 | 7 | 6 77 | 6.98 | 1554 |
| 1403 | " Corn Manure | 0.66 | 0.43 | 2.49 | 3.48 | 3.29 | 11.79 | 6.38 | 1.27 | 1.38 | 9.03 | | 7.65 | 7.5 | 9.61 | 7.64 | 7 | 6.88 | 7.23 | 1403 |
| 1545 | " Potato Fertilizer No. 2 | - - | 0.21 | 2 87 | 2.58 | 1.81 | 8.60 | 7.64 | 2.21 | 2.06 | 11.91 | | 9.85 | 9.25 | 12.42 | 3.97 | 4 | 3.57 | 3.66 | 1545 |

*Reprinted from Bulletin 45. †The manufacturers claim that the guarantee is incorrectly stated on the bags in the two shipments from which the sample was taken; that the correct guarantee is nitrogen 2.47 per cent, available phosphoric acid 8 per cent, potash 8 per cent.

‡The manufacturers claim that the guarantee is incorrectly stated on the bags from which this sample was taken, and that the correct guarantee is available phosphoric acid 11 per cent., potash 2 per cent.

## LICENSED FERTILIZERS SAMPLED BY STATION.

| Station Number. | BRAND. | MANUFACTURER. | DRAWN FROM STOCK OF | Station Number. |
|---|---|---|---|---|
| 1270 | Nobsque Guano | Pacific Guano Co., Boston, Mass. | F. R. Foote, West Cornwall | 1270 |
| 1261 | Almont Brand Ammoniated Guano | Powers, Gibbs & Co., Wilmington, N. C. | Edward Hayes, Wells | 1261 |
| 1260 | Sea Bird Ammoniated Guano | “ “ “ | Edward Hayes, Wells | 1260 |
| 1262 | Special Potato Fertilizer | “ “ “ | Edward Hayes, Wells | 1262 |
| 1263 | Special Small Grain Fertilizer | “ “ “ | Edward Hayes, Wells | 1263 |
| 1473 | Market Garden Manure | Quinnipiac Co., Boston, Mass. | Mellen & Proctor, Brattleboro | 1473 |
| 1229 | Phosphate | “ “ “ “ | S. M. Bartlett, West Burke | 1229 |
| 1228 | Potato Manure | “ “ “ “ | S. M. Bartlett, West Burke | 1228 |
| 1555 | Fish, Bone and Potash | Read Fertilizer Co., Syracuse, N. Y. | S. D. Whiting, Johnson<br>R. Nott, Burlington | 1555 |
| 1286 | Farmers' Friend Superphosphate | “ “ “ | S. D. Whiting, Johnson | 1286 |
| 1656 | Pacific Guano | John S. Reese & Co., Baltimore, Md. | S. C. Otis, West Burke | 1556 |
| 1557 | Potato Phosphate | “ “ “ | S. C. Otis, West Burke | 1557 |
| 1558 | Standard | “ “ “ | S. C. Otis, West Burke | 1558 |
| 1280 | A Brand | Standard Fertilizer Co., Boston Mass. | J. H. Bushnell, Williston | 1280 |
| 1278 | Fertilizer | “ “ “ | J. H. Bushnell, Williston | 1278 |
| 1546 | Guano | “ “ “ | C. W. Atherton, Waterbury<br>J. H. Bushnell, Williston | 1546 |
| 1298 | Potato and Tobacco Manure | “ “ “ | C. W. Atherton, Waterbury | 1298 |
| 1224 | Americus Ammo. Bone Superphos. | Williams & Clark Co., New York, N. Y. | S. W. Bartlett, West Burke | 1224 |
| 1547 | Americus Potato Phosphate |  | O. L. Miner, Brattleboro<br>S. M. Bartlett. West Burke | 1447 |

## ANALYSES OF LICENSED FERTILZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1270 | Pacific Guano Co's Nobsque Guano | - - - | - - - | 1.33 | 1.33 | 0.91 | $ 4.39 | 4.63 | 2.98 | 2.85 | 10.41 | | 7.56 | 9. | $ 9.92 | 2.42 | 2. | $2.18 | 3.19 | 1270 |
| 1261 | Powers,Gibbs&Co.'s Almont ...... | - - - | 0.11 | 1.06 | 1.17 | 0.82 | 3.91 | 6.79 | 2.08 | 2.75 | 11.62 | | 8.87 | 8. | 11.54 | 3.22 | 3. | 2.90 | 3.12 | 1261 |
| *1260 | “ “ Sea B'd Guano | - - - | - - - | 1.81 | 1.81 | 1.23 | 5 97 | 7.75 | 1.86 | 1.97 | 11.58 | | 9.61 | 8. | 12.13 | 2.67 | 2. | 2.40 | 2.91 | 1260 |
| 1262 | “ “ Spec. Potato.. | - - - | - - - | 2.25 | 2.25 | 2.05 | 7.43 | 7.73 | 0.84 | 0.48 | 9.00 | | 8.57 | 8. | 10.37 | 8.21 | 8. | 7.39 | 8.17 | 1262 |
| 1263 | “ “ Spec. Sm. Grn | - - - | - - - | 1.04 | 1.04 | 0.82 | 3.43 | 6.25 | 2.79 | 8.12 | 12.16 | | 9.04 | 8. | 11.82 | 1.99 | 2. | 1.79 | 1.99 | 1263 |
| 1473 | Quinnipiac Market Garden Manure | 0.99 | - - - | 2.48 | 3.47 | 3.3 | 11.15 | 4.52 | 3.97 | 2.68 | 11.17 | 9. | 8.49 | 8. | 10.86 | 6.59 | 7. | 5.93 | 7.47 | 1473 |
| *1229 | “ Phosphate............. | 0.53 | - - - | 2.52 | 3.05 | 2.47 | 9.91 | 6.95 | 1.91 | 1.70 | 10.56 | 10. | 8.86 | 9. | 11.12 | 2.58 | 2.5 | 2.32 | 2.90 | 1229 |
| 1228 | “ Potato Manure ........ | 0.37 | 0.12 | 2.02 | 2.51 | 2.47 | 8.22 | 3.96 | 1.95 | 2.49 | 8.40 | 7. | 5.91 | 6. | 7.90 | 4.82 | 5. | 4.34 | 5.25 | 1228 |
| 1555 | Read's Fish, Bone and Potash..... | - - - | 0.12 | 2.51 | 2.63 | 2.47 | 8.73 | 3.16 | 1.74 | 0.97 | 5.87 | 6. | 4.90 | 4. | 6.10 | 4.91 | 4. | 4.42 | 6.11 | 1555 |
| *1286 | “ Farmer's Friend.......... | 0.82 | - - - | 1.49 | 2.31 | 2.05 | 7.38 | 6.61 | 2.32 | 0.77 | 9.70 | 10. | 8.93 | 9. | 10.79 | 2.18 | 2. | 1.96 | 4.44 | 1286 |
| 1556 | J. S. Reese & Co.'s Pacific Guano . | - - | 0.16 | 1.88 | 2.04 | 1.89 | 6.80 | 3.72 | 6.22 | 1.65 | 11.59 | 10.5 | 9.94 | 8.5 | 11.97 | 1.47 | 1.2 | 1.41 | 0.69 | 1556 |
| 1557 | “ “ Potato Phosphate | - - - | - - - | 2.05 | 2.05 | 2.05 | 6.77 | 5.50 | 4.01 | 2.29 | 11.80 | 9.5 | 9.51 | 8.5 | 11.93 | 5 31 | 6. | 4.78 | 5.76 | 1557 |
| 1558 | “ “ Standard.... .... | - - - | - - - | 2.22 | 2.22 | 2.47 | 7.33 | 4.55 | 5.87 | 2.85 | 12.27 | 10. | 9.92 | 9. | 12.31 | 2.08 | 2. | 1.87 | 2.64 | 1558 |
| 1280 | Standard A Brand............... | - - - | - - - | 1.55 | 1.55 | 1.23 | 5.12 | 5.89 | 1.98 | 2.21 | 10.08 | | 7.87 | 8. | 10.13 | 1.92 | 2. | 1.73 | 2.94 | 1280 |
| *1278 | “ Fertilizer.... ........... | 0.29 | - - - | 2.00 | 2.29 | 2 | 7.47 | 5.73 | 2.41 | 2.16 | 10.30 | 10. | 8.14 | 8. | 10.38 | 2.36 | 2. | 2.12 | 3.38 | 1278 |
| 1546 | “ Guano................. | 0.22 | - - - | 1.26 | 1.48 | 1 | 4.82 | 6.80 | 2.01 | 1.35 | 9.66 | 10. | 8.31 | 8. | 10 31 | 2.43 | 2. | 2.19 | 3.16 | 1546 |
| 1298 | “ Potato and Tobacco..... | 0.58 | - - - | 1.67 | 2.25 | 2.05 | 7.25 | 5.36 | 3.10 | 2.54 | 11.00 | 9. | 8.46 | 8. | 10.86 | 3.36 | 3. | 3.02 | 4.70 | 1298 |
| *1224 | W. & C. Co.'s Amer. Ammo. Bone | 0.35 | 0.13 | 2.34 | 2.82 | 2.47 | 9.25 | 6.87 | 2.82 | 1.76 | 10.95 | 10. | 9.19 | 9. | 11.44 | 2.55 | 2. | 2.30 | 2.95 | 1224 |
| 1547 | “ Amer. Potato Phos.. | 0.95 | - - - | 2.05 | 3.00 | 2.47 | 9.61 | 4.47 | 1.61 | 1.87 | 7.95 | 7. | 6.08 | 6. | 7.89 | 5.35 | 5. | 4.99 | 3.15 | 1547 |

*Reprinted from Bulletin 45.

## ANALYSES OF LICENSED FERTILITERS.—(Reprinted from Bulletin 46.)

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1533 | Bowker's Farm and Garden Phos | 0.86 | - - - | 1.05 | 1.91 | 1.6 | $ 6.05 | 4.00 | 3.64 | 5.67 | 13.31 | 10. | 7.64 | 8. | $11.07 | 1.95 | 2. | $1.78 | 1.31 | 1533 |
| 1521 | " Hill and Drill Phosphate | 0.54 | 0.23 | 2.03 | 2.80 | 2.5 | 9.17 | 6.93 | 2.34 | 3.59 | 12.86 | 12. | 9.27 | 9. | 12.33 | 2.29 | 2. | 2.06 | 2.90 | 1521 |
| 1522 | " Stckbdg. for Potat's, &c. | 1.48 | - - - | 1.81 | 3.24 | 3.25 | 10.26 | 6.28 | 2.39 | 2.20 | 10.87 | 8. | 8.67 | 6. | 11.05 | 7.37 | 7. | 6.63 | 7.60 | 1522 |
| 1504 | Bradley's Corn Phosphate | - - - | - - - | 2.28 | 2.28 | 2.05 | 7.52 | 6.91 | 2.25 | 2.34 | 11.50 | 10. | 9.16 | 9. | 11.70 | 2.02 | 1.5 | 1.82 | 2.11 | 1504 |
| 1502 | " Eclipse Phosphate | - - - | 0.13 | 2.15 | 2.28 | 1. | 7.68 | 6.61 | 2.93 | 2.32 | 11.86 | 12. | 9.54 | 10. | 12.08 | 1.86 | 1.5 | 1.67 | 1.91 | 1502 |
| 1503 | " Potato Fertilizer | 0.22 | 0.18 | 1.88 | 2.28 | 2.05 | 7.53 | 6.05 | 2.76 | 2.48 | 11.29 | 11. | 8.81 | 9. | 11.29 | 3.38 | 3.25 | 3.04 | 3.48 | 1503 |
| 1523 | " Potato Manure | 0.21 | 0.16 | 2.16 | 2.53 | 2.5 | 8.36 | 3.92 | 2.19 | 2.29 | 8.40 | 8. | 6.11 | 6. | 8.03 | 5.31 | 5. | 4.78 | 5.65 | 1523 |
| 1501 | " X. L. Superphos. of Lime | 0.44 | 0.18 | 1.91 | 2.53 | 2.5 | 8.29 | 7.00 | 2.56 | 1.72 | 11.28 | 11. | 9.56 | 9. | 11.91 | 2.58 | 2. | 2.32 | 2.26 | 1501 |
| 1530 | Cleveland Corn and Grain Phos. | 0.48 | 0.14 | 1.80 | 2.42 | 2.05 | 7.90 | 6.15 | 2.87 | 2.61 | 11.63 | 10.5 | 9.02 | 9.5 | 11.58 | 1.90 | 1.5 | 1.71 | 2.66 | 1530 |
| 1505 | " Fertilizer for all Crops | - - - | - - - | 1.53 | 1.53 | 1.05 | 5.05 | 6.06 | 2.07 | 2.00 | 10.13 | 9. | 8.13 | 8. | 10.35 | 2.16 | 2. | 1.94 | 3.15 | 1505 |
| 1527 | " Potato Phosphate | - - - | 0.13 | 2.01 | 2.14 | 2.05 | 7.11 | 5.96 | 3.81 | 2.16 | 10.93 | 10. | 8.77 | 8. | 11.10 | 3.23 | 3. | 2.91 | 3.98 | 1527 |
| 1532 | Coe's Ammo. Bone Superphosphate | - - - | 0.16 | 1.65 | 1.81 | 1.25 | 6.05 | 7.42 | 1.99 | 2.87 | 12.28 | 9. | 9.41 | 8. | 12.24 | 1.60 | 1.35 | 1.62 | 0.28 | 1532 |
| 1518 | " Columbian Potato Fertilizer | - - - | - - - | 1.60 | 1.60 | 1. | 5.28 | 7.34 | 1.88 | 3.31 | 12.53 | 11. | 9.22 | 9. | 12.20 | 1.74 | 1.85 | 1.76 | 0.33 | 1518 |
| 1525 | " Columbian Corn Fertilizer | - - - | 0.16 | 1.38 | 1.54 | 1. | 5.15 | 7.05 | 2.42 | 3.04 | 12.51 | 11. | 9.47 | 9. | 12.34 | 1.86 | 1.85 | 1.89 | 0.88 | 1525 |
| 1531 | " Grass and Grain Fertilizer | - - - | - - - | 1.11 | 1.11 | 0.8 | 3.66 | 6.62 | 3.17 | 3.82 | 13.61 | 10. | 9.79 | 9. | 12.96 | 1.64 | 1.35 | 1.68 | 0.20 | 1531 |
| 1507 | Crocker's Ammo. Corn Phosphate | - - - | 0.16 | 2.02 | 2.18 | 2. | 7.26 | 7.56 | 2.68 | 1.68 | 11.82 | 11. | 10.19 | 10. | 12.62 | 1.92 | 1.6 | 1.73 | 1.89 | 1507 |
| 1508 | " New Rival Ammo. Sup. | - - - | - - - | 1.44 | 1.44 | 1.2 | 4.75 | 6.83 | 3.39 | 1.35 | 11.57 | 11. | 10.22 | 10. | 12.47 | 1.81 | 1.6 | 1.73 | 0.85 | 1508 |

ANALYSES OF LICENSED FERTILIZERS.—(Reprinted from Bulletin 46.)

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Chlorin. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | | |
| 1506 | Crocker's Potato, Hop & Tobacco. | - - - | 0.18 | 1.92 | 2.10 | 2 | $7.00 | 7.89 | 2.28 | 1.17 | 11 34 | 11 | 10.17 | 10 | $12.44 | 3.52 | 3.25 | $3.17 | 3.14 | 1506 |
| 1519 | " Superior Rye & Oats Phos. | - - - | - - - | 1.34 | 1.34 | 0.82 | 4.42 | 5.84 | 2.52 | 2.44 | 10.80 | 9 | 8.36 | 8 | 10.76 | 1.98 | 2 | 1.78 | 2.04 | 1519 |
| 1509 | Cumberland Potato Fertilizer..... | 0.44 | 0.13 | 1.54 | 2.11 | 2.05 | 6.88 | 5.33 | 3.18 | 2.94 | 11.45 | 11 | 8.51 | 9 | 11.07 | 3.33 | 3 | 3.00 | 4.10 | 1509 |
| 1524 | " Superphosphate....... | 0.21 | 0.16 | 2.06 | 2.43 | 2.06 | 8.02 | 6.78 | 2.34 | 1.77 | 10.89 | 10 | 9.12 | 8 | 11.42 | 2.36 | 2 | 2.12 | 2.95 | 1524 |
| 1528 | Lister's Special Potato Fertilizer.. | - - - | 0.28 | 1.61 | 1.89 | 1.64 | 6.35 | 6.13 | 2.35 | 2.51 | 10.99 | .... | 8.48 | 8 | 10.95 | 2.90 | 3 | 2.61 | 2.83 | 1528 |
| 1510 | " Success Fertilizer.......... | - - - | 0.27 | 1.38 | 1.65 | 1.25 | 5.55 | 7.50 | 1.49 | 2.67 | 11.66 | .... | 8.99 | 9 | 11.71 | 2.01 | 2 | 1.81 | 2.02 | 1510 |
| 1511 | P. G. Co's Soluble Pacific Guano... | - - - | 0.18 | 2.19 | 2.37 | 2.25 | 7.89 | 6.90 | 1.81 | 1.80 | 10.51 | 10.5 | 8.71 | 8.5 | 10.99 | 2.53 | 2 | 2.28 | 3.04 | 1511 |
| 1512 | " Special Potato & Tobac. | 0.52 | - - - | 1.79 | 2.31 | 2. | 7.47 | 6.04 | 2.23 | 2.46 | 10.73 | 9 | 8.27 | 8 | 10.69 | 3.27 | 3 | 2.94 | 4.69 | 1512 |
| 1515 | Quinnipiac Climax Phosphate .... | - - - | - - - | 1.27 | 1.27 | 1.03 | 4.19 | 6.50 | 1.71 | 1.44 | 9.65 | 9 | 8.21 | 8 | 10.26 | 2.54 | 2 | 2.29 | 3.11 | 1515 |
| 1518 | " Corn Manure.......... | 0.24 | 0.14 | 1.84 | 2.22 | 2.06 | 7.31 | 6.14 | 2.85 | 2.43 | 11 42 | 10 | 8.99 | 9 | 11.48 | 1.94 | 1.5 | 1.75 | 2.49 | 1518 |
| 1514 | " Potato & Tobacco Fert. | 0.33 | 0.18 | 1.80 | 2.31 | 2.05 | 7.56 | 5.97 | 2.18 | 2.57 | 10.72 | 9 | 8.15 | 8 | 10.59 | 2.85 | 3 | 2.57 | 3.51 | 1514 |
| 1526 | Read's Leader Guano.............. | 0.17 | - - - | 1.01 | 1.18 | 0.82 | 3.84 | 4.50 | 2.32 | 1.44 | 8.26 | 8 | 6 82 | 7 | 8.53 | 2.43 | 2 | 2.19 | 5.18 | 1526 |
| 1529 | " Standard Superphosphate.. | 0.22 | - - - | 1.01 | 1.23 | 0.82 | 3.99 | 6.04 | 1.93 | 1.09 | 9.06 | 10 | 7.97 | 8 | 9.81 | 4.09 | 4 | 3.68 | 7.82 | 1529 |
| 1516 | W. & C. Co.'s Ammo. Corn Phos... | 0.35 | 0.13 | 1.80 | 2.28 | 2.05 | 7.47 | 6.19 | 2.66 | 2.65 | 11.50 | 10 | 8.85 | 9 | 11.41 | 1.72 | 1.5 | 1.55 | 2.32 | 1516 |
| 1520 | " Ammo. Potato & Tobac. | - - - | 0.14 | 2.03 | 2.17 | 2.05 | 7.22 | 6.17 | 2.83 | 2.45 | 11.45 | 9 | 9.00 | 8 | 11.50 | 3.17 | 3 | 2.85 | 2.94 | 1520 |
| 1517 | " Royal Bone Phosphate | - - - | - - - | 1.32 | 1.32 | 1.03 | 4.36 | 6.12 | 1.60 | 1.77 | 9.49 | 8 | 7.72 | 7 | 9.82 | 2.56 | 2 | 2.30 | 3.18 | 1517 |

## IV. COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1894 AND IN 1895.

Of the ninety-seven brands of commercial fertilizers sold in the State during 1894 and 1895, and found by our sampling agents, forty-seven standard brands have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands were selected which have been found by us both of the years.

### AVERAGE COMPOSITION OF FERTILIZERS IN 1894 AND 1895.

| NAME OF INGREDIENTS. | 1894. | | 1895. | |
|---|---|---|---|---|
| | Pounds in a Hundred. | Valuation at 1895 Prices. | Pounds in a Hundred. | Valuation at 1895 Prices. |
| Nitrogen | 2.24 | $7.39 | 2.24 | 7.39 |
| Soluble Phosphoric Acid | 5.24 | 6.29 | 5.90 | 7.08 |
| Reverted Phosphoric Acid | 3.04 | 3.34 | 2.47 | 2.72 |
| Insoluble Phosphoric Acid | 2.18 | 0.87 | 2.35 | 0.94 |
| Available Phosphoric Acid | 8.28 | | 8.37 | |
| Total Phosphoric Acid | 10.46 | | 10.72 | |
| Potash | 2.99 | 2.69 | 3.10 | 2.79 |
| Total valuation per ton | | $20.58 | | $20.92 |

A comparison of the average compositions for 1894 and 1895 in the upper table shows but little change. The increase in valuation amounts to but thirty-four cents. It was noted of last year's goods that "the average composition is much lower than that of any previous year since the Station began sampling and analyzing licensed fertilizers under the State law." The lower grade of the goods now sold, as compared with those sold earlier, is seen on reference to the lower table. The increase in potash over former years is due to the sale of several brands containing from 7 to 10 per cent. of this ingredient.

The average of analyses, selling prices, valuations, percentages of increase of cost over valuation,* and valuations of all at 1885 and at 1895 trade values of all the brands analysed each year since the Experiment Station has been in existence are shown in the following table:

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*The percentage of increase of cost over valuation. Example—1885 Brands cost $37.90, valuation $26.72; 37.90—26.72=$11.18, $11.18÷$26.72=42 per cent, i. e. $11.18 is the increase of the cost over the valuation, and 42 is the percentage of the same.

### AVERAGE ANALYSES OF ALL BRANDS.

| | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | 2.38 | 2.58 | 2.75 | 2.80 | 2.55 | 2.41 | 2.52 | 2.42 | 2.41 | 2.21 | 2.22 |
| Sol. Phos. Acid | 6.35 | 6.15 | 5.48 | 6.74 | 6.68 | 5.99 | 6.47 | 6.47 | 6.44 | 5.42 | 5.84 |
| Rev. " | 1.93 | 1.92 | 3.23 | 2.80 | 2.97 | 2.97 | 2.86 | 2.60 | 2.84 | 2.97 | 2.56 |
| Insol. " | 2.13 | 2.59 | 2.52 | 2.56 | 2.98 | 2.71 | 2.00 | 2.18 | 2.34 | 2.16 | 2.53 |
| Avail. " | 8.28 | 8.07 | 8.71 | 9.54 | 9.65 | 8.96 | 9.33 | 9.07 | 9.28 | 8.39 | 8.40 |
| Total " | 10.41 | 10.66 | 11.23 | 12.10 | 12.63 | 11.67 | 11.33 | 11.25 | 11.62 | 10.55 | 10.93 |
| Potash | 2.77 | 2.69 | 2.84 | 3.12 | 2.69 | 3.16 | 3.13 | 2.82 | 2.64 | 2.95 | 3.46 |
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| Av. selling price | 37.90 | 37.02 | 36.75 | 35.13 | 35.11 | 34.39 | 33.14 | 32.47 | 32.32 | 31.47 | 30.90 |
| Av. valuati'n by each yrs. price | 26.72 | 25.75 | 27.15 | 28.96 | 29.05 | 26.70 | 26.07 | 24.48 | 23.53 | 21.47 | 21.28 |
| Per ct. increase of cst. over val. | 42. | 44. | 35. | 21. | 21. | 29. | 27. | 33. | 37. | 47. | 45. |
| Val. by '85 pr'cs | 26.72 | 27.21 | 28.86 | 30.88 | 30.03 | 28.52 | 29.16 | 28.22 | 28.46 | 25.84 | 26.25 |
| Val. by '95 pr'cs | 20.94 | 21.46 | 22.77 | 24.24 | 23.31 | 22.23 | 22.84 | 22.02 | 22.13 | 20.59 | 21.28 |

Although the best goods were sold in 1888-89, it does not follow that more plant food was bought for a dollar then than now, since both crude stock and mixed goods have fallen in price. Last year the showing was not favorable. "The plant food which cost a dollar in 1894, cost ninety-four cents in 1888." The table given above shows that this year's goods cost on the average 57 cents less per ton and valued (at 1895 prices) 69 cents more per ton, or in the standard goods (see upper table) 34 cents more per ton. This is sufficient to turn the scale. The plant food which cost a dollar in 1895, cost the same in 1888, and a dollar and a quarter in 1885. In other words the Vermont buyer pays as low for commercial fertilizers in 1895 as at any time before. But if former prices were fair he should pay less than ever before, because of the present low prices of fertilizing ingredients in crude stock. From 1889 to 1895 the average selling price has fallen $4.21 or 12 per cent., the average valuation, $7.70, or 29 per cent. In other words the decrease in the selling price has not been proportionate to the decrease in the actual cost of crude stock.

The wide percentage of increase of cost over valuation in 1894 and 1895 should be noted. It is a serious question to the large buyer whether he can afford to pay 45 per cent. of the gross cost of the plant food he buys for the items of mixing, bagging, freight and selling. The home mixing system (see p. ) has much to recommend it to such.

## V. ANALYSES OF WOOD ASHES, MUCK, ETC.

| Station Number. | Source. | RECEIVED FROM. | Soluble Potash. | Insoluble Potash. | Total Potash. | Total Phos. Acid. | Insoluble Matter. |
|---|---|---|---|---|---|---|---|
| 1165 | Canada. | E. O. Lee, Vernon | 4.64 | | | | |
| 1166 | " | F. H. Atwood, Westminster | 4.32 | 1.26 | 5.58 | 2.17 | |
| 1167 | " | " " | 5.39 | 2.10 | 7.49 | 3.35 | |
| 1168 | " | " " | 4.81 | 2.40 | 7.21 | 2.88 | |
| 1169 | " | J. W. Boyce, Guildhall | 5.20 | 2.60 | 7.80 | 1.42 | |
| 1170 | " | W. H. Cole, Westminster | 4.34 | 1.54 | 5.85 | 1.97 | |
| 1171 | " | J. W. Boyce, Guildhall | 9.53 | 0.14 | 9.67 | 4.49 | 5.13 |
| 1172 | " | Victor I. Spear, Braintree | 6.50 | 0.00 | 6.50 | 3.11 | 7.76 |
| 1173 | " | A. A. Duncklee, So. Vernon | 4.01 | 1.99 | 6 00 | 2.96 | 11.09 |
| 1174 | Vermont. | " " | 6.84 | 0.04 | 6.88 | 5.23 | 13.71 |
| 1175 | " | C. A. Hinsdill, No. Bennington | 3.36 | 0.96 | 4.42 | 3.07 | 12.20 |
| 1176 | " | " " | 5.90 | 1.31 | 7.21 | 2.89 | 17.05 |
| 1177 | " | " " | 3.60 | 0.15 | 3.75 | 2.91 | 10.75 |
| 1178 | | F. H. Atwood, Westminster | 5.21 | 1.15 | 6.36 | | |
| 1179 | | " " | 6.05 | 0.08 | 6.13 | | |
| 1180 | Limekiln. | W. B. Fonda, St. Albans | 3.86 | 0.44 | 4.30 | 1.49 | |
| 1181 | | H. A. Barker, Burlington | 5.28 | 1.58 | 6.86 | 1.54 | 8.50 |

### ANALYSES OF MUCK AND MISCELLANEOUS MATERIAL.

| Station Number. | RECEIVED FROM. | Moisture. | Ash. | Volatile and Organic | Nitrogen. | Nitrogen in Dry Matter. | Phosphoric Acid. |
|---|---|---|---|---|---|---|---|
| 1182 | Muck, J. N. Baxter, Rutland | 87.96 | | | 0.29 | 2.42 | |
| 1183 | " O.K. Fletcher, Hinesburgh | 80.23 | | | 0.27 | 1.37 | |
| 1184 | " (Pond) F. F. Gilbert, Dorset | 49.12 | | | 1.23 | 2.41 | |
| 1185 | " (Swamp) " " | 33.15 | | | 0.84 | 1.26 | |
| 1186 | " E. C. Orvis, Manchester | 51.22 | 10.52 | 38.26 | 1.37 | 2.81 | |
| 1187 | " W.L.Sylvester, W.Brattleb' | 57.00 | 31.65 | 11.35 | 0.63 | 1.47 | |
| 1188 | Odorless Guano, " " | 2.23 | | | 0.63 | | 19.44 |
| 1189 | Refuse Tannery Salt, M. V. Leach, Essex | 14.80 | | | 0.23 | 0.27 | 0.14 |
| 1190 | Liquid Refuse Soap W'k's. " | 91.00 | | | 1.00 | 11.06 | 0.07 |

1895.

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16 DEC 1895

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No 48.

OCTOBER, 1895.

# Gluten Feeds and Meals.

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II. SOURCE AND COMPOSITION. (Pages 63-70.)
III. FEEDING TESTS WITH GLUTEN PRODUCTS. (Pages 70-78.)
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    3. EFFECT ON QUALITY OF MILK. (Pages 77-78.)

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1895.

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# BULLETIN NO. 48, GLUTEN FEEDS AND MEALS.

By J. L. Hills.

## I. Summary.

**1. Gluten feeds and meals are by-products of glucose manufacture from corn. The bulk of the starch is removed, thus relatively increasing the protein or flesh-forming portions and the fat.**

**2 The various gluten feeds consist of the entire dried waste products of this manufacture. Being rich in protein and fat and containing the bran of the corn, which lightens the mass and improves its physical condition, they are well adapted for dairy feeding, and may be fed with comparative safety.**

**3. The various gluten meals contain neither the bran nor the germ, and are much richer than the gluten feeds. They should be fed with more care because of their concentration.**

**4. The corn germ residues are comparatively rich, while the brans are poor.**

**5. Feeding tests made at this Station tend to show that Cream and King gluten meals have a decidedly greater, Chicago Maize feed, a somewhat greater, and Corn Germ feed the same feeding value as equal weights of bran and corn meal.**

**6. These feeds also seemed to produce a very slightly richer milk, one in which the fat is disproportionately increased.**

## II. Source and Composition.

The Sixth Report of this Station contained an account of feeding tests with Cream Gluten meal, Buffalo Gluten feed and Corn Germ feed, three by-products of the manufacture of glucose or grape sugar from corn. The article included analyses of these goods and a short description of the methods of their manufacture. Inasmuch as this report was not distributed to the entire mailing list, and many inquiries indicate desire for information regarding the gluten products, the present account of further feeding trials with these materials is prefaced with analyses and descriptions of the various gluten feeds and meals now placed upon the market.

The Station has analysed nearly thirty samples of these materials, the results of some having been published in former reports while others have not as yet been printed. These together with several analyses reported by other stations * have been used in making up the data given in the succeeding tables.

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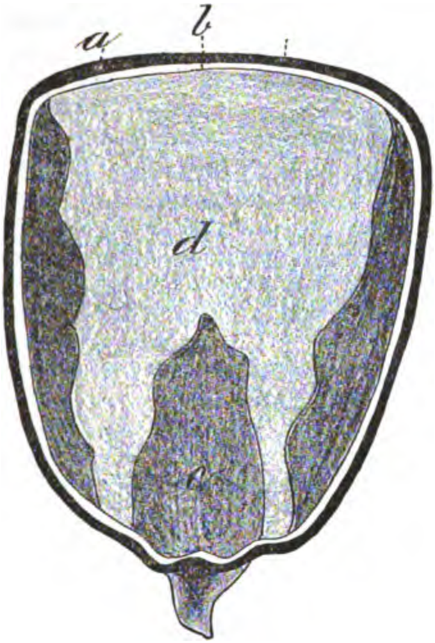
* U. S. Dept. Agr., Farmers' Bulletin, No. 22; Mass. Agl. Expt. Station, Report for 1894 New Jersey Ag'l Expt. Station, Bulletin No. 105.

The cattle foods sold under the gluten name are the output of a dozen or more different factories and are usually by-products of glucose manufacture. A few dried distillery refuses (such as "grano-gluten" and "Atlas gluten meal") are also termed gluten feeds, although perhaps not strictly entitled to the name. The names even of the more strictly gluten products, are often somewhat indefinite and poorly descriptive, and the buyer frequently fails to distinguish between gluten *feed* and gluten *meal*. It is hoped that a study of the analyses and descriptions here given will aid the farmer to a better understanding of the difference between them, as well as of the variations existing in the makes of the different firms.

The corn kernel is rich in starch and poor in protein. The removal of a large proportion of the former in the course of glucose manufacture relatively increases the percentage of the latter in the residues. The protein is next to the starch the most abundant nutrient present in the kernel and hence becomes of controlling importance in proportion as the starch is removed. The effect of the removal of two-thirds of the starch upon the composition of the kernel is clearly shown in the following table based on the average of nearly 300 analyses as published by Jenkins and Winton (Dept. Agr. Office of Expt. Stations, Bulletin No. 11.)

| | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Extract. | Ether Extract. |
|---|---|---|---|---|---|
| Corn Kernel, | 1.70 | 11.70 | 2.40 | 78.10 | 6.10 |
| If two-thirds of the starch is removed, | | | | 52.07 | |
| there would remain 47.93 lbs. of residue containing | 1.70 | 11.70 | 2.40 | 26.03 | 6.10 |
| with a composition per hundred pounds of | 3.55 | 24.41 | 5.01 | 54.30 | 12.73 |

The manufacturing processes, however, do not remove starch alone, nor do they remove all of it. At best, starch is still a preponderating nutrient in gluten products, while most of the ash ingredients and some protein and other nutrients are separated mechanically with the starch. The by-products may be expected to vary therefore according to (1) the variations in the composition of the corn; (2) the perfection and details of the manufacturing processes.



The accompanying cut, kindly loaned by the New Jersey Experiment Station, shows on an enlarged scale the structure of the corn kernel.

The husk or skin (a) covers the seed and consists of two layers which make up the bran and which contain nearly all the crude fiber of the kernel. Underneath this lies a layer of yellow cells (b) rich in gluten. The germ (c) located at the base of the grain and is the richest part of the seed, while the main portion (d) is largely made up of starch. The darker portions on each side of the cut represent the more yellow flinty parts, the lighter, the more purely starchy portions.

The following analyses, also from Bulletin No. 105 of the New Jersey Station, shows the composition of the skin (a), germ (c) and starchy portion (d). It was found impossible to make perfect separations, and the skin and germ included some of the gluten cells and starchy parts. These analyses will be useful in connection with the study of tables given later in the bulletin.

| | Amount secured from 100 parts of original corn. | Water. | COMPOSITION OF DRY MATTER. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Extract. | Ether Extract. | Nitrogen | Phosphoric Acid. | Potash. |
| Original Corn | 100.00 | 24.74 | 1.73 | 12 65 | 2.02 | 79.26 | 4.34 | 2.02 | 0.88 | 0.47 |
| Skin | 5.56 | 15.29 | 1.27 | 6.60 | 16.45 | 75.36 | 1.59 | 1.06 | 0.23 | 0.38 |
| Germ | 10.17 | 29.62 | 11.13 | 21.71 | 2.88 | 45.79 | 29.62 | 3.48 | 6.16 | 2.91 |
| Starchy and hard part | 84.27 | 24.66 | 0.68 | 12.23 | 0.65 | 85.58 | 1.54 | 1.96 | 0.35 | 0.17 |

The following table is suggestive, showing the distribution of the various nutrients in the different parts:

DISTRIBUTION OF NUTRIENTS. PER CENT. OF THE ENTIRE NUTRIENT PRESENT IN ORIGINAL CORN FOUND IN EACH PART.

| | Entire Part. | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen Free Extract. | Ether Extract. | Nitrogen. | Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|---|---|---|---|
| Skin | 6½ | 5 | 3 | 53 | 6 | 2 | 3 | 2 | 4 |
| Germ | 9½ | 61 | 16 | 12 | 5 | 65 | 16 | 71 | 59 |
| Starchy and hard parts | 84 | 33 | 81 | 27 | 81 | 30 | 81 | 35 | 30 |

These per cents. do not always add up to 100 owing to the difficulties in methods of sampling and to analytical errors. They serve, however, to point out clearly the location of the nutrients in the grain. The composition of the germ is particularly interesting. Two-thirds of the fat and potash and three-quarters of the phosphoric acid of the kernel are lodged in the germ.

### METHOD OF MANUFACTURE OF GLUTEN PRODUCTS.

The primal object of the glucose factory is the manufacture of grape sugar from the separated starch, the gluten residues being by-products. There are slight differences in the details of manufacture as conducted by the various concerns, but in general the process is as follows:

The whole corn is soaked in warm water for many hours until swollen and thoroughly softened. It is then run through stones set quite a distance apart. This rubs off the husk and the germ and at the same time beats up the starch and the gluten. The mass is then sifted through fine sieves, the starch and gluten passing through, the husk and the germ remaining behind to be separated if desired by gravity, the husks floating and the germs sinking in water. The starch and gluten which have passed through the sieves are separated by running into large tanks and settling, or by slowly running through long troughs. The starch, being heavier, settles to the bottom, while the lighter yellow gluten-containing material runs off from the top.

The sulphuric acid used in the manufacture of the glucose acts only on the starch, and not until it has been thus mechanically separated from those portions which are sold as cattle feeds. There is nothing whatever in these feeds except what was contained in the original whole corn, and there appears to be no reason why they should not be as easily digestible and as perfectly healthy as corn meal.

If we follow out the process of manufacture outlined above, we find that three distinct classes of by-products may be formed:

1. Corn Bran, the husk or skin of the kernel.
2. Corn Germ.
3. Gluten Meal, the light yellow gluten-containing material floating on the settling tanks or troughs.

No. 1 alone sometimes enters the market as "corn bran" or "corn hulls." The germs are often extracted or pressed to get out the "maize oil" and the residues sold as "corn oil cake." Nos. 1 and 2 (the latter after extraction) are sometimes mixed together and called "corn germ feed." No. 3 is what is known in the market as *Gluten Meal.* If all three are mixed together the product is called *Gluten Feed.*

The following tables show the average composition of various brands of gluten products on our markets with maximum and minimum, indicating variations which may occur in products of the same general name. They are arranged in accordance with their per cents of protein and fat.

GLUTEN FEEDS.

| Brand.* | Source of Data. | Number of Analyses. | Water. | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Extract. | Ether Extract. | Nitrogen. | Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chicago (1) | N. J. | 1 | 7.61 | 0.87 | 24.03 | 6.31 | 47.00 | 14.18 | 3.84 | | |
| Pope (2) | Vt. | 1 | 8.12 | 1.02 | 24.78 | 6.12 | 51.97 | 7.75 | 3.96 | 0.36 | 0.10 |
| Buffalo (3) | Dept. Ag. Mass, NJ Vt | 27 | 8.18 | 0.99 | 23.07 | 6.66 | 49.05 | 12.05 | 3.69 | 0.31 | 0.10 |
| Chicago Maize (1) | " " " " | 12 | 8.87 | 1.04 | 23.10 | 7.65 | 52.32 | 7.02 | 3.70 | 0.37 | 0.07 |
| Peoria (4) | " " " " | 4 | 7.28 | 0.92 | 20.81 | 7.80 | 49.88 | 13.33 | 3.33 | | |
| Dry (5) | N. J. | 1 | 6.33 | 0.59 | 17.61 | 5.34 | 61.82 | 8.31 | 2.82 | | |
| | Minimum † | | 6.33 | 0.70 | 19.54 | 1.50 | 44.50 | 4.95 | 3.13 | | |
| | Maximum † | | 10.20 | 1.80 | 28.30 | 9.68 | 58.00 | 14.84 | 4.53 | | |
| | **Average** | | **8.23** | **0.99** | **22.82** | **6.97** | **50.27** | **10.72** | **3.65** | **0.33** | **0.09** |

*These goods were manufactured by (1) Chicago Sugar Refining Co., Chicago, Ill.; (2) Chas. Pope Glucose Co., Geneva, Ill.; (3) American Glucose Co., Buffalo, N. Y.; (4) Peoria Grape Sugar Co., Perola, Ill.; (5) National Starch Mfg. Co., New York.

† Exclusive of "Dry Gluten Feed" which is of notably lower feeding value than the others.

With one exception these feeds are mixtures of the three by-products, bran, germ and meal, presumedly in the proportions in which they are made. The Chicago Maize Feed has no germ residue in it.

If we compare the average analysis (exclusive of the "Maize Feed") with the composition of the corn kernel from which two-thirds of the starch is taken we find close agreement.

| | Water. | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Ext. | Ether Extract. |
|---|---|---|---|---|---|---|
| Gluten Feed, | 8.00 | 0.97 | 22.72 | 6.73 | 49.55 | 12.03 |
| Corn, less two-thirds starch, | 8.00 | 3.27 | 22.46 | 4.60 | 49.96 | 11.71 |

Protein, starch and fat agree closely, while ash is lacking, having fallen with the starch in the mechanical separation and soaked out in the steeping water. Probably more than two-thirds of the starch is separated in the manufacturing process, but it also takes down with it more or less of the protein, so that the final result is much the same so far as the by-product is concerned. Were it not that the roughages usually contain a plentiful supply of bone-making material the loss of the ash would be a serious matter. As it is it serves to lessen the fertilizing value of the gluten products. It is claimed that by a recent improvement in the process of manufacture of the Buffalo goods, the loss of ash, hitherto unavoidable, has been obviated.

### GLUTEN MEALS.

| Brand.* | Source of Data. | Number of Analyses. | Water. | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Extract. | Ether Extract. | Nitrogen. | Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cream (1)........ | Dept. Ag. N. J. Vt. . | 5 | 7.95 | 0.98 | 37.69 | 1.74 | 36.40 | 15.24 | 6.03 | 0.36 | 0.20 |
| King (2)......... | Mass., N. J., Vt. .. | 5 | 7.56 | 2.29 | 36.60 | 1.40 | 32.80 | 19.35 | 5.86 | 0.76 | 0.07 |
| Chicago (3)...... | Dep.Ag.MassN.J.Vt. | 17 | 9.60 | 1.11 | 32.58 | 1.06 | 48.44 | 7.21 | 5.21 | 0.39 | 0.06 |
| Flour (4)......... | N. J.................. | 1 | 8.54 | 1.09 | 30.27 | 0.87 | 47.65 | 11.78 | 4.84 | | |
| Golden (5)....... | Mass., N. J., Vt. .... | 3 | 7.49 | 1.21 | 30 29 | 3.27 | 47.16 | 10.58 | 4.85 | 0.42 | 0.06 |
| Hammond (6).. | N. J.................. | 1 | 7.85 | 1.00 | 26.56 | 1.12 | 52.99 | 10.48 | 4.25 | | |
| | Minimum.......... ... | | 6.65 | 0.60 | 26.56 | 0.58 | 32.15 | 4.60 | | | |
| | Maximum.... ..... .. | | 11.11 | 3.97 | 42.96 | 3.60 | 57.97 | 21.94 | | | |
| | Average..... ......... | | 8.74 | 1.28 | 33.58 | 1.42 | 44.11 | 10.92 | 5.38 | 0.45 | 0.08 |

*Manufactured by (1) Chas. Pope Glucose Co., Geneva, Ill.; (2) National Starch Man'f'g Co., New York; (3) Chicago Sugar Refining Co., Chicago, Ill.; (4) Continental Food Product Co., Waukegan, Ill.; (5) Firmenich Man'f'g Co., Marshalltown, Iowa; (6) Stein, Hirsh & Co., Chicago, Ill.

Little if any stress should be laid in the above table on the precedence of the Cream over the King brand or of the Chicago over either of the next two following. The Cream brand has one per cent. more protein but 4 per cent. less fat than the King, the Chicago 2½ per cent. more protein but from ½ to 4½ per cent. less fat. So far as analyses serves to show, the Cream and

King brands are of about equal value, followed by the next three in a bunch. The Chicago brand has noticeably less fat than the others. Judged by this single sample the Hammond goods are but little richer than some gluten feeds.

As a whole, the gluten meals contain half as much again of protein as the feeds, one-fifth as much of crude fiber and but seven-eighths as much of starch. They are, in other words, more concentrated, less bulky and consequently more dangerous to feed in liberal quantities.

### CORN GERM AND HULL PRODUCTS.

| Brand. | Source of Data. | Number of Analyses. | Water. | Crude Ash. | Crude Protein. | Crude Fiber. | Nitrogen-free Extract. | Ether Extract. | Nitrogen. | Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chicago Oil Cake.... | N. J. .................... | 2 | 9.48 | 2.44 | 25.32 | 7.31 | 43.75 | 11.70 | 4.05 | 0.54 | 0.06 |
| Pope Oil Cake.... .. | N. J., Vt. ............. | 8 | 9.04 | 2.54 | 23.04 | 8.65 | 39.88 | 16.72 | 3.69 | 1.17 | 0.29 |
| Corn Germ Feed.... | Dep.Ag.Mass.N.J.Vt | 9 | 7.35 | 1.08 | 11.27 | 10.85 | 58.55 | 10.80 | 1.80 | 0.18 | |
| Corn Bran........ .. | N. J. .................... | 2 | 8.52 | 0.81 | 11.37 | 11.50 | 59.72 | 8.08 | 1.82 | 0.10 | 0.02 |

The oil cakes are made from corn germs after partial removal of the oil (fat) by naptha and by hydraulic pressure. Corn germ feed is a mixture of germ and hull, and corn bran is the skin of the kernel. The latter two can hardly be termed high-grade products.

### VALUE OF GLUTEN PRODUCTS AS CATTLE FOODS.

All of these products, with the possible exception of the latter two, have a high value as cattle foods.

The digestibility of Buffalo gluten feed has been determined by Goessmann,[*] and of gluten meal[†] by Jordan,[‡] to be respectively:

| | Dry Matter. | Protein. | Fiber | Nitrogen-free Extract. | Fat. |
|---|---|---|---|---|---|
| Buffalo Gluten Feed, | 78 | 85 | 43 | 81 | 81 |
| Gluten Meal, | 87 | 87 | | 91 | 88 |
| Corn Meal, | 87 | 60 | | 92 | 92 |

The gluten products appear as digestible as corn meal. Their palatability cannot be as surely vouched for. Some of them, especially the more concentrated ones, are not readily eaten by some cows. Neither appearance nor analysis indicate the reason for this dislike occasionally observed.

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[*] Mass. Ag'l Expt. Stat. Report for 1893.

[†] Brand not stated; judging by the analysis given it is probably Chicago.

[‡] Maine Ag'l Expt. Stat., Report for 1891, p. 37-39.

It should be remembered that the gluten products, particularly the meals, are highly concentrated, and if fed freely may cause sickness. The gluten feed, because of the admixture with bran and consequent better mechanical condition, may be fed in large quantities more safely than the gluten meals. The amounts which may safely be fed vary with the animal.

The differences in price between gluten meals and feed are frequently out of proportion to their actual food values. It may frequently prove economical to buy the more concentrated though more costly meal and if necessary mix it with wheat bran or something of that nature upon the farm, than to buy the safer and bulkier gluten feed.

The fertilizing value of these by-products should not be forgotten. Since the ash falls by gravity with the starch and is soaked out in the steeping water, the feeds, meals, etc., are lacking in phosphoric acid and potash. They are rich in nitrogen, however, and aid the manure pile and farm with fertility obtained without direct outlay. The following table shows the pounds of nitrogen, phosphoric acid and potash in a ton of average gluten feed and meal, with value at the ruling prices. A considerable part of this may be obtained in the manure pile and placed upon the land if properly handled.

POUNDS PER TON.

| | Nitrogen. | Phosphoric Acid. | Potash. | Value Per Ton. |
|---|---|---|---|---|
| Gluten Feed, | 73.0 | 6.6 | 1.8 | $11.36 |
| Gluten Meal, | 107.6 | 9.0 | 1.6 | 16.66 |

## III. FEEDING TESTS WITH GLUTEN PRODUCTS.

The results of feeding trials made at this station with Cream Gluten Meal, Corn Germ Feed and Buffalo Gluten Feed, by-products of the manufacture of glucose from corn, were reported on pages 143-158 of the Sixth report. Since these were completed four more feeding trials have been made with other and somewhat similar products, viz: King Gluten Meal and Chicago Maize Feed.

Analyses and methods of manufacture have already been discussed in the earlier pages of this bulletin in connection with similar data on other by-products of the same class.

The trials were made during the spring of 1894 and during the winter of 1894-95 on seven and eight cows respectively. It was designed to use an eighth cow in the earlier test, but she was found to be tuberculous and was killed. The following tables show the cows used, and the nature of the grain rations fed during the different periods :

| Name. | Age. Apl.1 | Calved | Served | Pounds fed daily Mar. 29—April 26 | Pounds fed daily April 26—May 24 | Pounds fed daily May 24—June 21 |
|---|---|---|---|---|---|---|
| Blossom .... | | Oct. 24 | Nov. 27 | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn |
| Rena Myrtle | 7 | Mar. 2 | farrow | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn |
| Gretchen ... | 4 | Oct. 21 | farrow | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten |
| Minerva .... | 11 | Nov. 25 | Dec. 26 | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten |
| Josie ......... | | Nov. 18 | farrow | 8, Maize feed | 4, bran, 4, corn | 8, Maize feed |
| Lolita......... | 7 | Jan. 8 | farrow | 8, Maize feed | 4, bran, 4, corn | 8, Maize feed |
| Dorothy .... | 7 | Feb. 11 | farrow | 4, bran, 4, corn | 8, Maize feed | 4, bran, 4, corn |

| Name. | Age. Dec.1 | Calved | Served | Pounds fed daily Nov. 26—Dec. 24 | Pounds fed daily Dec. 24—Jan. 21 | Pounds fed daily Jan. 21—Feb. 19 |
|---|---|---|---|---|---|---|
| Jessaline. .. | | Sept... | Jan. 12 | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn |
| Regina. ..... | 6 | Sept... | farrow | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn |
| Waxy........ | | Sept... | Jan. 10 | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten |
| Jersey Lily.. | 4 | Sept... | Jan. 16 | 2, bran, 2, corn<br>4, King gluten | 4, bran, 4, corn | 2, bran, 2, corn<br>4, King gluten |
| Jeannie...... | 6 | Nov. 23 | Jan. 27 | 8, Maize feed | 4, bran, 4, corn | 8, Maize feed |
| Goldie ....... | 9 | June .. | Sept. 23 | 8, Maize feed | 4, bran, 4, corn | 8, Maize feed |
| Lolita .. .... | 8 | Jan. 8 | Jan. 15 | 4, bran, 4, corn | 8, Maize feed | 4, bran, 4, corn |
| Julia ........ | 6 | Mar. .. | July 9 | 4, bran, 4, corn | 8, Maize feed | 4, bran, 4, corn |

Rena Myrtle and Lolita are registered Ayrshires, Gretchen, an Ayrshire Jersey cross, the remainder high grade Jerseys. The cows were not weighed during the first feeding test, but were during the second trial, the mean of the weights on the three consecutive days at the beginning of the first and end of all three periods being shown in the following table:

| Period. | Jessaline. | Regina. | Waxy. | Jersey Lily. | Jeannie. | Goldie. | Lolita. | Julia. |
|---|---|---|---|---|---|---|---|---|
| I beginning. | 778 | 738 | 705 | 720 | 793 | 842 | 1157 | 774 |
| I end ....... | 802 | 738 | 701 | 728 | 817 | 828 | 1160 | 786 |
| II end ...... | 837 | 718 | 702 | 735 | 807 | 823 | 1189 | 810 |
| III end ..... | 843 | 719 | 691 | 745 | 820 | 875 | 1234 | 820 |

Five of the cows, Jessaline, Jersey Lily, Jeannie, Lolita and Julia made a steady gain in weight. Regina, who was off her feed badly, lost, Waxy about held her own and Goldie decreased in weight at first and increased later on.

The first series of tests was begun as soon as the Station barn had been disinfected after the slaughter of our former herd and the cows moved in. This was so late, however, that the cows went out to pasture in the middle of the second period and consequently ate less roughage than when in the barn. It is thought that this has not seriously affected the experiment, or altered the conclusions drawn, although it probably altered some of the data obtained. Check tests on other cows strengthen us in this belief.

The daily rations in addition to the grain feed were:

Test I. Period 1., 8 pounds hay: 2., 6 pounds hay; 3, 4 pounds hay. Corn ensilage ad libitum after the hay was eaten up.

Test II. From 14 to 25 pounds of hay daily.

The roughage orts were almost entirely ensilage in the first test. The King gluten meal was not readily eaten in either test by some of the cows, there frequently being a considerable amount left behind. This was so mixed up with the other orts that it could not be weighed. There was, therefore, in some cases with the cows eating King gluten meal somewhat more roughage and less meal eaten than the table shows. Thus if we find these cows doing better on smaller weights of King gluten meal than on bran and corn, it is equivalent to saying that the material has even a higher feeding value than our experiments would seem to give it.

The following tables show the gross amounts of the various foods eaten in each eighteen days which constituted the experimental portion of the four week periods:

| | April 9-26. | | | | | May 7-24. | | | | | June 4-21. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hay. | Ensilage. | ½ Corn Meal. ½ Bran. | King Gluten Meal. | Maize Feed. | Hay. | Ensilage. | ½ Corn Meal. ½ bran. | King Gluten Meal. | Maize Feed. | Hay. | Ensilage. | ½ Corn Meal. ½ Bran. | King Gluten Meal. | Maize Feed. |
| Blossom | 144 | 813 | 144 | .... | ... | 98 | 387 | 72 | 72 | .... | 68 | 304 | 136 | .... | .... |
| Rena Myrtle | 144 | 512 | 144 | .... | .... | 100 | 294 | 72 | 72 | .... | 68 | 217 | 136 | .... | .... |
| Gretchen | 144 | 622 | 72 | 72 | .... | 98 | 355 | 144 | .... | .... | 64 | 82 | 64 | 64 | .... |
| Minerva | 144 | 462 | 72 | 72 | .... | 100 | 182 | 144 | .... | .... | 72 | 257 | 72 | 72 | ... |
| Josie | 144 | 309 | .... | .... | 144 | 98 | 160 | 144 | .... | .... | 72 | 83 | .... | .... | 144 |
| Lolita | 128 | 610 | .... | .... | 128 | 98 | 245 | 144 | .... | .... | 72 | 193 | .... | .... | 144 |
| Dorothy | 144 | 585 | 144 | .... | .... | 98 | 262 | .... | .... | 144 | 72 | 286 | 144 | .... | .... |

| | Dec. 7-24. | | | | | Jan. 4-21. | | | | | Feb. 2-19. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jessaline | 364 | .... | 144 | .... | .... | 413 | .... | 72 | 72 | .... | 444 | .... | 144 | .... | .... |
| Regina | 382 | .... | 144 | .... | .... | .... | .... | .... | .... | .... | 257 | .... | 144 | .... | .... |
| Waxy | 244 | .... | 72 | 72 | .... | 331 | .... | 144 | .... | .... | 345 | .... | 72 | 72 | .... |
| Jersey Lily | 341 | .... | 72 | 72 | .... | 319 | .... | 144 | .... | .... | 331 | .... | 72 | 72 | .... |
| Jeannie | 243 | .... | 144 | .... | .... | 210 | .... | .... | .... | 144 | 211 | .... | 144 | .... | .... |
| Goldie | 345 | .... | 144 | .... | .... | 327 | .... | .... | .... | 144 | 348 | .... | 144 | .... | .... |
| Lolita | 361 | .... | .... | .... | 144 | 390 | .... | 144 | .... | .... | 393 | .... | .... | .... | 144 |
| Julia | 341 | .... | .... | .... | 144 | 319 | .... | 144 | .... | .... | 347 | .... | .... | .... | 144 |

The first ten days of each feeding period was considered as preparatory, then samples were taken of the milk for the next six days; then the next six days were omitted and samples again taken for the last six days. The milk of the middle six days was weighed and it was considered to have the same composition as the average of the six days preceding and following.

### 1. KING GLUTEN MEAL.

In each test two cows had King gluten during the first and third period, and bran and corn during the second, while two others ate bran and corn meal during the first and third periods, and King gluten meal during the second.

The average of the first and third period then may be considered as what the cows would have yielded during the second period if they had eaten the same grain feed as at the beginning and end of the test, and a comparison of this average with what was actually yielded will serve to show the relative value of the different feeds. Regina refused King gluten meal and went off her feed so that we have but seven comparisons as shown below :

| | April 9-26. | | | | | May 7-24. | | | | | June 4-21. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
| Cow. | Bran and Corn Meal. | | | | | King Gluten Meal, | | | | | Bran and Corn Meal. | | | | |
| Blossom....... | 344.9 | 14.33 | 4.92 | 50.42 | 16.97 | 425.4 | 14.34 | 5.01 | 61.00 | 21.32 | 313.4 | 14.50 | 5.01 | 45.44 | 15.69 |
| Rena Myrtle .. | 710.9 | 12.63 | 3.85 | 89.80 | 27.38 | 836.8 | 12.51 | 3.87 | 104.71 | 32.38 | 814.1 | 12.35 | 3.78 | 100.32 | 30.38 |
| | King Gluten Meal. | | | | | Bran and Corn Meal. | | | | | King Gluten Meal. | | | | |
| Gretchen..... .. | 420.3 | 13.89 | 4.54 | 58.28 | 19.10 | 400.0 | 14.10 | 4.78 | 56.39 | 19.12 | 437.5 | 13.69 | 4.37 | 59.87 | 19.10 |
| Minerva.. .. .. | 240.4 | 14.15 | 4.98 | 34.12 | 11.97 | 227.3 | 13.92 | 4.73 | 31.53 | 10.75 | 229.6 | 13.66 | 4.76 | 31.44 | 10.93 |

| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Blossom. | | | | | Rena Myrtle. | | | | |
| Av.2 Bran & Corn periods | 329.2 | 14.42 | 4.97 | 47.93 | 16.33 | 762.5 | 12.49 | 3.79 | 95.06 | 28.88 |
| Int'ven'g King gluten " | 425.4 | 14.34 | 5.01 | 61.00 | 21.32 | 836.8 | 12.51 | 3.87 | 104.71 | 32.38 |
| Diff. in favor King glut'n | +96.2 | −0.08 | +0.04 | +13.07 | +4.99 | +74.3 | +0.02 | +0.08 | +9.65 | +3.50 |
| | Gretchen. | | | | | Minerva. | | | | |
| Av.2 King gluten periods | 428.8 | 13.77 | 4.45 | 59.07 | 19.10 | 235.0 | 13.90 | 4.87 | 32.78 | 11.45 |
| Inte'vng Corn & Bran " | 400. | 14.10 | 4.78 | 56.39 | 19.12 | 227.3 | 13.92 | 4.73 | 31.53 | 10.75 |
| Diff. in favor King glut'n | +28.8 | −0.37 | −0.33 | +2.68 | −0.02 | +7.7 | +0.02 | +0.14 | +1.25 | +0.70 |

| | Dec. 6-24. | | | | | Jan. 4-21. | | | | | Feb. 2-19. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
| Cow. | Bran and Corn Meal | | | | | King Gluten Meal. | | | | | Bran and Corn Meal. | | | | |
| Jessaline ..... | 325.6 | 13.25 | 4.50 | 43.14 | 14.66 | 419.6 | 13.95 | 4.97 | 58.54 | 20.87 | 335.4 | 13.70 | 4.66 | 45.96 | 15.64 |
| | King Gluten Meal. | | | | | Bran and Corn Meal. | | | | | King Gluten Meal. | | | | |
| Waxy ....... .. | 309.3 | 14.11 | 5.29 | 43.66 | 16.37 | 362.9 | 13.52 | 4.32 | 49.08 | 15.69 | 347.4 | 13.83 | 4.75 | 48.04 | 16.49 |
| Jersey Lily.... | 354.3 | 14.82 | 5.62 | 52.50 | 19.93 | 347.2 | 15.21 | 5.65 | 52.81 | 19.63 | 394.2 | 14.73 | 5.42 | 58.06 | |

| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Jessaline. | | | | | Regina. | | | | |
| Av.2 Bran&Corn periods | 330.5 | 13.48 | 4.58 | 44.56 | 15.55 | | | Sick. | | |
| Int'vn'g King gluten " | 419.6 | 13.95 | 4.97 | 58.51 | 20.87 | | | | | |
| Difference in favor of King Gluten............ | +89.1 | +0.47 | +0.39 | +13.98 | +5.72 | | | | | |
| | Waxy. | | | | | Jersey Lily. | | | | |
| Av.2 King gluten periods | 328.4 | 13.97 | 5.02 | 45.85 | 16.43 | 374.2 | 14.78 | 5.52 | 55.28 | 20.65 |
| Inte'vng Corn & Bran " | 362.9 | 13.52 | 4.32 | 49.08 | 15.69 | 347.2 | 15.21 | 5.65 | 52.81 | 19.63 |
| Difference in favor of King Gluten............ | −32.5 | +0.45 | +0.70 | −3.23 | +0.74 | +27.0 | −0.43 | −0.13 | +2.47 | +1.02 |

### DIFFERENCES IN FAVOR OF KING GLUTEN MEAL.

| Seven trials. | Pounds Milk. | Per cent. of Total Solids. | Per cent. of Fat. | Pounds of Total Solids. | Pounds of Fat. |
|---|---|---|---|---|---|
| Total, | 288 | | | 39.87 | 16.67 |
| Average, | 41 | 0.01 | 0.15 | 5.70 | 2.38 |
| Per cent. increase, | 10 | 0 | 3 | 11 | 13 |

These results show very plainly the high feeding value of King gluten meal as compared with bran and corn. It should be noted too, that these figures are, if anything, too low, because of the large amount of orts left from the King gluten meal. There were seven cases in which cows were fed this King gluten meal. In six of these cases the flow of milk was increased, in two cases the quality (richness) of the milk was much improved, in three cases there was a slight improvement in quality but not enough to be important, in the remaining two cases the milk was of poorer quality. In four cases out of the seven there were decided gains in butter fat, in three cases slight gains and in one case no change in the seven trials. The average shows one-tenth more milk of slightly richer quality yielding an eighth more butter as a result of the substitution of four pounds of King gluten meal for four pounds of equal parts bran and corn. It should be remembered that all gluten meals are so highly concentrated that they should be fed with caution. The large percentage of protein and fat they contain are apt to cause digestive troubles and throw the animals off their feed.

In a feeding experiment designed to test the effects of any given food it is desirable to feed as much as possible of it in order that its effects if any may be magnified. We threw one cow entirely off her feed with four pounds a day, and others were frequently close to the danger line. It would probably be unwise in ordinary feeding to give as much as four pounds of any of the gluten meals to most cows.

### 2. CHICAGO MAIZE FEED.

This by-product is less concentrated than the King gluten meal and was fed,more freely, the bran and corn being entirely replaced by it, when it was fed. It resembles bran somewhat in analysis, except thet it contains much more fat. The results of the use of this material in two series of tests on seven cows follow :

| | April 9-26. | | | | | May 7-24. | | | | | June 4-21. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
| Cow. | Bran and Corn Meal. | | | | | Maize Feed. | | | | | Bran and Corn Meal. | | | | |
| Dorothy | 530.8 | 14.00 | 4.58 | 74.32 | 24.30 | 532.4 | 13.76 | 4.80 | 73.24 | 25.55 | 486.1 | 13.97 | 4.97 | 67.91 | 24.17 |
| | Maize Feed, | | | | | Bran and Corn Meal. | | | | | Maize Feed. | | | | |
| Josie | 269.3 | 13.89 | 4.62 | 37.41 | 12.44 | 260.1 | 13.86 | 4.68 | 36.06 | 12.18 | 261.5 | 13.73 | 4.74 | 35.91 | 12.41 |
| Lolita | 628.0 | 12.96 | 3.94 | 81.38 | 24.76 | 561.3 | 12.90 | 3.81 | 72.41 | 21.41 | 624.9 | 12.83 | 4.00 | 80.18 | 24.79 |

| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dorothy. | | | | | | | | | |
| Av. 2 Bran & Corn periods | 509 | 13.99 | 4.78 | 71.11 | 24.24 | | | | | |
| Inter'vng Maize feed " | 532 | 13.76 | 4.80 | 73.24 | 25.55 | | | | | |
| Diff. in favor Maize feed | + 23 | −0.23 | +0.02 | +2.13 | +1.31 | | | | | |
| | Josie. | | | | | Lolita. | | | | |
| Av. 2 Maize feed periods | 265 | 13.81 | 4.68 | 36.66 | 12.43 | 627 | 12.90 | 3.97 | 80.78 | 24.78 |
| Inter'vng Bran & Corn " | 260 | 13.86 | 4.68 | 36.06 | 12.18 | 561 | 12.90 | 3.81 | 72.41 | 21.41 |
| Diff. in favor Maize feed | + 5 | −0.05 | 0.00 | +0.60 | +0.25 | + 66 | 0.00 | +0.16 | +8.37 | +3.37 |

| | Dec. 7-24. | | | | | Jan. 4-21. | | | | | Feb. 2-19. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
| Cow. | Bran and Corn Meal. | | | | | Maize Feed. | | | | | Bran and Corn Meal. | | | | |
| Jeannie | 211.6 | 14.58 | 5.06 | 30.86 | 10.71 | 223.8 | 14.86 | 5.11 | 33.27 | 11.43 | 208.7 | 14.82 | 5.23 | 30.92 | 10.91 |
| Goldie | 243.1 | 15.60 | 6.16 | 37.92 | 14.97 | 376.3 | 15.15 | 5.58 | 57.03 | 20.99 | 271.4 | 15.23 | 5.57 | 41.35 | 15.13 |
| | Maize Feed. | | | | | Bran and Corn Meal. | | | | | Maize Feed. | | | | |
| Lolita | 173.7 | 11.59 | 3.52 | 20.15 | 6.13 | 139.3 | 11.27 | 3.36 | 15.70 | 4.69 | 115.4 | 11.03 | 3.28 | 12.73 | 3.78 |
| Julia | 240.2 | 15.96 | 6.27 | 38.33 | 15.06 | 227.0 | 16.00 | 6.08 | 36.31 | 13.81 | 198.1 | 16.40 | 6.69 | 32.49 | 13.26 |

| | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. | Pounds Milk. | Total Solids. % | Fat. % | Total Solids. lbs. | Fat. lbs. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Jeannie. | | | | | Goldie. | | | | |
| Av. 2 Bran & Corn periods | 210.1 | 14.70 | 5.14 | 30.89 | 10.81 | 257.3 | 15.42 | 5.87 | 39.64 | 15.05 |
| Inter'vng Maize feed " | 223.8 | 14.86 | 5.11 | 33.27 | 11.43 | 376.3 | 15.15 | 5.58 | 57.03 | 20.99 |
| Diff. in favor Maize feed | +13.7 | +0.16 | −0.03 | +2.38 | +0.62 | +119.0 | −0.27 | −0.29 | +17.39 | +2.94 |
| | Lolita. | | | | | Julia. | | | | |
| Av. 2 Maize feed periods | 144.6 | 11.31 | 3.39 | 16.44 | 4.95 | 219.1 | 16.18 | 6.48 | 35.40 | 14.16 |
| Inter'vng Bran & Corn " | 139.3 | 11.27 | 3.36 | 15.70 | 4.69 | 227.0 | 16.00 | 6.08 | 36.31 | 13.81 |
| Diff. in favor Maize feed | + 5.3 | +0.04 | +0.03 | +0.74 | +0.26 | − 7.9 | +0.18 | +0.40 | −0.90 | +0.35 |

DIFFERENCE IN FAVOR OF CHICAGO OR MAIZE FEED.

| | Pounds | Per cent of | | Pounds of | |
|---|---|---|---|---|---|
| | Milk. | Total Solids. | Fat. | Total Solids. | Fat. |
| Seven trials. | | | | | |
| Totals, | 224 | | | 30.74 | 9.10 |
| Average, | 32 | —0.02 | +0.04 | 4.39 | 1.30 |
| Per cent increase, | 10 | 0 | 1. | 10. | 10. |

More milk was given in three cases out of the seven and essentially the same amounts in four cases. The quality of the milk was practically unchanged and as a result the variations in yields of total solids and of fat run practically parallel with those in the amounts of milk. The increase was very marked in two cases, in the others there was but little difference. The average increase, a tenth of the total product, is largely due to these two causes. It is interesting to note that Lolita when fresh in milk increased her milk and butter yield one-eighth on maize feed, but when a stripper did no better on it than on bran and corn. These tests would seem to indicate that the maize feed had at least as much and probably a little more feeding value than a mixture of equal parts bran and corn meal. It is not equal to King gluten meal, but is not unlike the corn germ feed both in composition and feeding value.

### 3. EFFECT ON QUALITY OF MILK.

A table showing the effects of the by-products of corn upon the quality of milk as shown in the ratio of the fat to the solids not fat, will be of interest in connection with the question of their effect upon the quality of the milk.

| Meal. | No. of Cows. | Total Solids. | Fat. | Solids not Fat. | Ratio of Fat to Solids not Fat. |
|---|---|---|---|---|---|
| Bran and Corn, | 3 | 13.84 | 4.53 | 9.31 | 1:2.06 |
| Cream Gluten Meal, | 3 | 14.10 | 4.90 | 9.20 | 1:1.88 |
| | | +0.26 | +0.37 | —0.11 | —0.18 |
| Bran and Corn, | 3 | 13.66 | 4.42 | 9.24 | 1:2.09 |
| Buffalo Gluten Feed, | 3 | 13.59 | 4.47 | 9.12 | 1:2.04 |
| | | —0.07 | +0.05 | —0.12 | —0.05 |
| Bran and Corn, | 3 | 13.58 | 4.45 | 9.13 | 1:2.05 |
| Corn Germ Feed, | 3 | 13.65 | 4.58 | 9.07 | 1:1.98 |
| | | +0.07 | +0.13 | —0.06 | —0.07 |
| Bran and Corn, | 7 | 13.88 | 4.69 | 9.19 | 1:1.96 |
| King Gluten Meal, | 7 | 13.89 | 4.82 | 9.07 | 1:1.88 |
| | | +0.01 | +0.15 | —0.12 | —0.08 |
| Bran and Corn, | 7 | 14.02 | 4.82 | 9.20 | 1:1.91 |
| Chicago Maize Feed, | 7 | 14.00 | 4.86 | 9.14 | 1:1.88 |
| | | —0.00 | +0.04 | —0.06 | —0.03 |

The average results all agree in showing a higher per cent of fat and a lower per cent of solids not fat as a result of the substitution of the by-products for the corn and bran. This difference is greatest on the richer foods, namely cream gluten meal and king gluten meal. Each of the three cows fed cream gluten and five of the seven fed king gluten meal narrowed the ratio of fats to solids not fat, while the two remaining did not change it. These figures show a general tendency of the gluten meals and feeds to produce a slightly richer milk. The gain, however, is too slight on the whole to lay much stress upon; yet it is added testimony to their worth when considered in connection with the decided gain in milk flow usually produced.

These experiments, together with those noted in the sixth report tend to show;

(1) That cream gluten meal, King gluten meal and Buffalo gluten feed each has a considerably greater feeding value pound for pound than has equal parts of corn meal and bran, while corn germ feed has about the same feeding value, and Chicago maize feed has little greater feeding value than has the corn meal and bran;

(2) That the feeding of these by-products seems to produce a slightly richer milk, one in which the fat is disproportionately increased. The change, however, is not sufficiently marked to be of practical importance.

1895.

# VERMONT
# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 49.

DECEMBER, 1895.

## Potato Blights and Fungicides.

I. Summary. (Page 81.)
II. Selection of "Seed" a Preventive of Late Blight. (Pages 82–83.)
III. Test of Various Forms of Bordeaux Mixture. (Pages 83–89.)
IV. Various Forms of "Potato Blight." (Pages 89–99.)
  1. The Late Blight. (Page 90–91.)
  2. The Early Blight. (Page 91–96.)
  3. Arsenical Poisoning. (Page 97–98.)
  4. Tip Burn. (Page 98–99.)
V. Frost Injury to Apples and Pears. (Page 100.)

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FREE PRESS ASSOCIATION.
1896.

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Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 49. POTATO BLIGHTS AND FUNGICIDES.

BY L. R. JONES.

## I. SUMMARY.

II. The late blight attacked potatoes in 1895 two weeks later than might be expected, judging from the condition of weather alone. This delay was due to the unusual freedom from rot of "seed" potatoes grown in the dry summer of 1894. It is probable that similar results might be secured every year if healthy seed potatoes were selected entirely from fields of early potatoes which escaped the late blight. (Pages 82-83.)

III. Comparative trials of various forms of the liquid Bordeaux mixture and of the dry Bordeaux powders were made in 1895. The results show that the freshly made liquid mixture of standard strength is superior to all others. By its use the yield of marketable potatoes on the trial plots was more than doubled. (Pages 83-89.)

For the best way to make Bordeaux mixture, see page 88.

IV. The term "Blight" is popularly applied to the premature dying of potato leaves from any cause. Successful treatment of any disease requires that the cause be distinctly understood.

The chief potato leaf diseases are:

1. The Late Blight (or mildew) and Rot. Cause, the fungus Phytophthora infestans.

Preventive measures: Plant tubers free from the disease and make two or three applications of Bordeaux mixture. (Pages 90-91.)

2. The Early Blight (or leaf-spot disease). Cause, the fungus Macrosporium Solani, usually attacking weakly plants.

Preventive measures: Increase the general vigor of the plants by selection of varieties, better preparation. fertilization and cultivation of the soil, and later planting; spray with Bordeaux mixture. (Pages 91-96.)

3. Arsenical Poisoning. Cause, improper use of Paris green, etc.

Preventive measures: Apply smaller amounts of the Paris green dry and diluted with plaster. or add lime to the water if this is used as a carrier of the poison. (Pages 97-98.)

4. Tip Burn. Cause, dry hot weather aided by any other conditions unfavorable to the plant.

Preventive measures: Increase the general vigor of the plant as in No. 2, and irrigate during dry weather if practicable. (Pages 98-99.)

V. Late frosts in the spring of 1895 caused a serious russeting of the surface of apples and pears. (Page 100.)

*Introductory note*—Attention has been called in previous bulletins to the fact that two distinct fungus diseases or "blights" of the potato occur commonly in Vermont. These have been described under the popular names of "early blight" and "late blight." The "late blight" or familiar "rust" is the dreaded disease which rapidly sweeps over the field during warm "muggy" weather in August or September, and which is always followed by the "rot" of the tuber, this rot being caused by the growth within the tuber of the same fungus which causes the blighting of the leaves. The "early blight" is an entirely different disease, which is characterized by a spotting of the leaves but does not cause any rotting of the tubers. This early blight together with various disorders liable to confusion with it, are fully described later in this bulletin.

## II. SELECTION OF "SEED" AS A PREVENTIVE OF LATE BLIGHT.

The destructive occurrence of potato blights in Vermont is dependent upon the condition of weather between July and September. This is especially true of the late blight and rot. It is usually safe to predict that the late blight will appear destructively upon potato fields about Burlington at any time after July 25th, when the weather continues warm and rainy for a week or more. This was not the case, however, in 1895. Early in August the usual warm rainy weather set in and persisted with more or less continuity through the month. Yet there was no general outbreak of the late blight. How is this to be explained? As stated in previous accounts of this disease, the fungus causing it lives over winter in diseased potato tubers, and so far as known, only in this way. Owing to the continued drought of 1894, there was during that season but little opportunity for the development of the late blight and the accompanying rot. Consequently the seed potatoes raised in this vicinity in 1894, and planted in 1895, were almost entirely free from this disease.

Had they been absolutely so there would have been no appearance of the blight in 1895. But careful examination of our own crop in the autumn of 1894 showed that there was an occasional case of "dry rot" among the tubers. This indicated the presence of enough of the disease to insure its survival through the winter in many of the apparently healthy tubers. There were, however, so few diseased tubers planted as compared with ordinary years, and these original centers of infection were consequently so much fewer in the fields, that the blight was fully two weeks later in getting under headway than is ordinarily the case under the same climatic conditions. One early piece of potatoes upon which we were experimenting, blighted quite badly in August. On all the other plots there was no destructive spread of the late blight before September 1st. Once well started, however, the disease spread persistently through September, and caused a large amount of rot in the later potatoes, while the early ones were practically free from the disease.

The experience of this year teaches a most important lesson, which if generally heeded wou'd save Vermont potato growers from the loss of thousands of dollars annually, viz : that *seed potatoes should be taken from a field which did not suffer from the late blight and the rot.* In the vicinity of Burlington the earliest planted potatoes, especially if on a light, dry, sandy soil, usually escape the late blight, Similar conditions exist throughout the State, and seed potatoes should be selected from such a source. If this were to become the *general practice* the saving would be incalculable. Unfortunately the careful individual must often suffer because of the continued propagation of contagious diseases, whether of plants or animals, by ignorant or slothful neighbors. One man alone cannot suppress an epidemic. Concerted action is necessary for the best results. There was, however, such a marked difference last year in the date of the appearance of the late blight in this vicinity upon plots of potatoes separated by only a short distance, that we believe that with potato fields more widely separated, as they are on ordinary farms, each man can do much by use of healthy seed to save his own crop in spite of the bad practice of less intelligent neighbors. Careful choice of seed, and in many cases the growing of a small piece of potatoes for seed purposes, is therefore strongly recommended as a preventive measure against the late blight and rot.

It is vain, however, to hope that any such precautionary measures as selection of seed, will do more than delay for a time the outbreak of the late blight, upon the average Vermont potato field when the weather is favorable.

## III. TEST OF VARIOUS FORMS OF BORDEAUX MIXTURE.

Our experience last summer only strengthened our previous conviction on the following points :

*First*, that it pays to protect both early and late potatoes in Vermont with fungicides as well as insecticides.

*Second*, that no other fungicide yet devised is at all equal to Bordeaux mixture for use on potatoes.

There are, however, various forms of Bordeaux mixture concerning the relative values of which we are frequently questioned. Experiments made at this station and elsewhere have shown that the Bordeaux mixture of medium strength, and freshly prepared as used, is superior to any other form for practical use on potatoes. Certain other forms of the mixture are, however, more conveniently made or applied, and it is often queried whether the advantages thus offered will not out-weigh the loss in quality of the mixture. We are often asked, for example, whether it will not do as well to make up in concentrated form as much mixture as will be needed for the season, and take from this "stock" mixture and dilute as needed for use. The question also is raised, whether when through spraying, the residue of the mixture should be kept and used in the next application or whether it should be thrown away.

The use of the dry powder guns for applying Paris green is meeting so much favor that many have asked whether Bordeaux mixture could not be prepared in the form of dry powder and applied with these guns in the same way as is done with Paris green.

In order to have experimental evidence upon these points one-half acre of potatoes was set aside in 1895 for a test of the comparative values of the following forms of Bordeaux mixture.

1. "*Standard*" *Bordeaux Mixture* freshly made as used. Ingredients: 1¼ pounds of copper sulphate, 1 pound of lime, 10 gallons of water. This is the mixture we have been recommending for practical use for the past year.

2. "*Test*" *Bordeaux Mixture*, freshly made as used. Ingredients, the same amounts of copper sulphate and water as in the standard mixture, (No. 1), but only enough lime added to neutralize the copper sulphate, as shown by testing with a solution of ferrocyanide of potassium.*

In preparing the mixture by this test it has been our experience that only about one-half as much lime is needed as is used in the standard mixture, that is to say, this "test" mixture actually contained in each ten gallons of water, 1¼ pounds of copper sulphate and about ½ pound of lime.

3. "*Stock*" *Bordeaux Mixture*, prepared at the beginning of the spraying season in July. This was made in the same way as the standard mixture except that only one-half as much water was used. This stock mixture was allowed to stand in open vessels during the summer. At the time of each application it was thoroughly stirred and from it as much as wished for immediate use was dipped out and diluted with equal parts of water so as to make it of the same strength as the standard mixture.

4. "*Bordeaux Powder*." This was prepared by making standard Bordeaux mixture as in No. 1, which was allowed to stand until the blue precipitate had settled. The clear water was then poured off the top, the blue precipitate thoroughly dried and then ground between millstones to the finest possible powder. This powder was applied on some plots dry and without dilution with a Leggett's Powder Gun, on other plots it was applied similarly, but diluted with wheat flour, and on still other plots it was mixed in

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*The object of this test is to avoid the trouble of weighing the lime and at the same time to prevent the danger of burning the leaves which would happen in case an insufficient amount of lime was used. The test consists in pouring a few drops of a solution of ferrocyanide of potassium into the mixture, after the lime has been added. If enough lime has not been added this solution turns brick red as soon as it enters the mixture, but if there is enough lime the solution will not change color.

water and applied with the spray pump in the same manner as the ordinary liquid mixtures.

5. "*Fungiroid.*" A powder similar to the above prepared and sold as a fungicide by Leggett and Brother of New York City. This was applied dry on some plots without dilution, on other plots diluted with wheat flour.

The field was planted May 20th with four varieties of potatoes, viz: Beauty of Hebron, Rural New Yorker No. 2, White Star and Polaris. These variety plots extended in rows running north and south. The plots were staked for experimental spraying crosswise of these rows so that each sprayed plot included all four varieties. As laid out in this way there were fifty-one rows to be used in the test. Of these, each third row was left untreated as a "check," there being thus 17 check rows.

The plan of spraying was as follows :

17 rows Check i. e. not sprayed.

12 rows "Standard" Bordeaux Mixture, (No. 1).

4 rows "Test" Bordeaux Mixture, (No. 2).

2 rows "Stock" Bordeaux Mixture, (No. 3).

6 rows "Bordeaux Powder," (No. 4), without dilution.

2 rows "Bordeaux Powder" applied dry after dilution with wheat flour in proportion of 1 part of the powder to 3 parts flour.

2 rows "Bordeaux Powder" mixed in water in proportion of 1 pound of the powder to 4 gallons of water* and applied with spray pump.

4 rows "Fungiroid," (No. 5), applied without dilution, dry.

2 rows "Fungiroid," applied dry after dilution in the proportion of one part of the Fungiroid to three parts flour.

The liquid mixtures were applied at the rate of about 125 gallons per acre in the first applications, and as the plants increased in size this was increased to about 200 gallons per acre in the third.

The amount of the dry powders used was made to agree as nearly as practicable with this, they being applied at the rate of about 40 pounds per acre, each application. Forty pounds of the dry Bordeaux powder contains the same amount of copper sulphate and lime as 160 gallons of the standard Bordeaux mixture.

The details regarding the arrangement of plots and yields will be left for our Annual Report. Suffice it to say here that the check rows and those treated with standard Bordeaux mixture were so scattered across the field as to give an opportunity to use both for close comparison in determining the relative value of each of the other methods of treatment. The idea governing this plan was that the standard Bordeaux mixture would serve as the highest standard of excellence, and that the "check" rows would represent the lowest limit. The results showed this presumption to be correct. The potatoes were purposely planted late in order to avoid complications with the various insect and early blight attacks of July. Three applications of each fungicide were made; the dates of application being as follows: first, July 25th; second, Aug. 13th; third, Aug. 31st.

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*These proportions gave a fungicide of the same chemical strength as the standard Bordeaux mixture.

The late or Phytophthora blight was later than usual in appearing, the first indication of its presence being detected about September 1st. From this date until the last of the vines were killed by frost, about Oct. 10th, this disease continued its depredations, the check rows being all killed off by the middle of September, and the others dying in the order indicated below. Oct. 1st, before a killing frost came, a critical examination of the field was made and from the appearance of the tops alone the various fungicides were graded in the following order as to relative value:

*First*, "Standard" Bordeaux mixture; the rows sprayed with this were in excellent condition.

*Second*, "Test" Bordeaux mixture; these rows were distinctly inferior to those sprayed with the standard mixture, although looking very well.

*Third*, "Stock" Bordeaux mixture; these rows were very uneven in appearance, some in pretty good condition, others entirely dead. (See probable explanation later.)

*Fourth*, "Bordeaux powder" applied in water; the remarks just made concerning the uneven condition of the rows sprayed with stock mixture apply equally to these rows.

*Fifth*, "Bordeaux powder" and "Fungiroid" applied undiluted as dry powders; these gave about equally poor results, the plants in both cases being nearly dead.

*Sixth*, "Bordeaux powder" and "Fungiroid" diluted with flour and applied dry; these had given so little protection that the plants were entirely dead and the rows indistinguishable from the "check" or untreated rows.

The results upon digging were even more convincing than the appearance of the vines. Owing to the continued progress of the disease for some weeks after the last spraying was done, there was considerable loss from the rot even where the Bordeaux mixture was used. Another application of this mixture in September would have prevented much of this and would have been very profitable. Since some of the plants treated with weaker fungicides were already dead it was impracticable to make a uniform application to all and therefore none was sprayed after September 1st.

The yields will be given in detail in our Annual Report. The following figures give in bushels per acre the yields of average rows, and fairly represent the whole:

TABLE SHOWING RELATIVE PROTECTION FROM USE OF VARIOUS FUNGICIDES.

| | Yields in Bushels per Acre. | |
|---|---|---|
| | Large Sound Tubers. | Large Rotten Tubers. |
| Standard Bordeaux mixture, freshly made | 365 | 57 |
| "Test" Bordeaux mixture | 332 | 74 |
| "Stock" Bordeaux mixture | 307 | 106 |
| Bordeaux powder, dry, undiluted | 235 | 177 |
| Fungiroid, dry, undiluted | 210 | 151 |
| Bordeaux powder, dry, diluted with flour | 173 | 194 |
| Check—no fungicide | 170 | 159 |

*Conclusions,* With these figures before us there can be no hesitation in drawing the following conclusions :

*Standard Bordeaux Mixture* (1¼ lbs. copper, 1 lb. lime, 10 gals. water,) *freshly prepared as used* is so distinctly superior to all others that it alone should be used. A convenient method of making is explained on page 88. If desired, the ferro-cyanide test can be conveniently used in its preparation.

"*Test*" *Bordeaux Mixture,* (1¼ lbs. copper sulphate, 10 gals. water, lime added by potassium ferro-cyanide test [about ¼ pound used] ) was not equal to the standard mixture.

It is not fully understood why the excess of lime in the standard mixture should increase its value as a fungicide. It is probable that the additional lime not only increases the adhesiveness of the mixture containing it but that it also gives it a somewhat different chemical composition.

"*Stock*" *Mixture,* or old mixture, is so distinctly inferior to the others that its use should be avoided so far as practicable, i. e., one should always aim to make up no more of the mixture than is to be used immediately, The mixture probably undergoes some chemical changes in standing but the chief point of deterioration appears to be in its mechanical condition. When first made and before it is allowed to settle it consists of the finest possible particles of the blue compound suspended in the water. As these particles settle they mass together forming small granules which cannot again be separated into the original particles by any process of stirring. Consequently the old mixture containing this granular matter settles more quickly in the reservoir of the pump. It was found impossible to apply it uniformly even on our experimental plots, it clogged the nozzles sooner, was less uniformly distributed over the leaf surface and more easily washed off by rain.

*Bordeaux Powders.* The above remarks apply equally to the Bordeaux powder where it was applied in water with the spray pump.

When these powders were applied dry even in most liberal amounts they gave so little protection that their substitution for the ordinary or wet mixture is not to be recommended under any circumstances.

The failure of the dry Bordeaux powders is to be attributed partly to their lack of adhesiveness, they being washed off from the plants more quickly by rains, and partly to the fact that it is impossible to cover the lower leaves of the older plants so thoroughly with the dry powder as can be done with the ordinary liquid mixture.

The powders as diluted with flour were much inferior to the undiluted powders.

## BEST WAY TO MAKE BORDEAUX MIXTURE.

It is some trouble to make Bordeaux Mixture. Most of the trouble, however, lies in the preparation, viz.: in the exact weighing out of ingredients and in the dissolving of the copper sulphate. Much of this can be avoided. Our own practice in making the mixture is as follows:

At the beginning of the spraying season we make a stock solution by dissolving 40 pounds of copper sulphate in 40 gallons of water in a clean kerosene barrel. The copper sulphate is placed in a bran sack which is hung in the barrel supported by a stick across the top so that the water barely covers the copper sulphate. Hung in this manner the material soon dissolves without stirring. This stock solution is then tightly covered for use from time to time. Whenever needed, a second 40-gallon barrel is filled half full of water, into which is strained 6 gallons of the stock solution, (equivalent to 6 pounds of copper sulphate). All that is then necessary is to add the freshly slacked lime. Since it is difficult to keep stone lime from air slacking (and it will not do to use air slacked lime,) the mason's practice of slacking a large amount of lime and allowing to stand in a box covered by water may be followed. In any case enough water should be added to the slacked lime before using to make it of the consistency of white-wash. A pailful of this white-wash is then strained slowly through as fine a sieve as it will pass into the copper solution, meanwhile stirring the latter. After thorough stirring this mixture is tested by adding a few drops of a solution of potassium ferrocyanide, which can be bought from any druggist. If this potassium solution turns brick red upon touching the surface of the mixture it shows that more lime is needed, in which event more "white-wash" is added until the potassium solution is no longer discolored. This makes the so-called "test" mixture. The experiments cited above, however, teach us that the standard mixture, which contains approximately twice as much lime is better. To bring this mixture up to "standard" strength the amount of lime already added must be doubled. This is done in a moment, for supposing that thus far three pailfuls of the "white-wash" have been added, three more are needed. Then water is added to fill the barrel, the whole stirred once more and it is ready for use. If for use on potatoes it is well to add to this barrel of mixture about ¼ pound of Paris green so as to poison the insects.

## IV. VARIOUS FORMS OF POTATO BLIGHT.

Until some five years ago it was supposed that potatoes in Vermont suffered seriously from only a single disease which was commonly called the "rust" or "blight" as it appeared on the leaves and the "rot" or "dry rot" as it attacked the tubers. The accepted cause of this disease was the fungus *Phytophthora infestans*. Examination of diseased plants in 1890-92 showed that this belief was only partially correct, and in the bulletins and report for 1892-93 a "new" disease was described and figured. This disease was described as causing distinct spots on the leaves, which began to appear in early mid-summer and which increased in number and slowly enlarged as the season progressed, often killing the early potatoes before the other blight or "rust" appeared. It was observed that this disease was never followed by the rot. To distinguish the two maladies the name "late blight" and rot was accepted for the well-known disease, while the name "early blight" was suggested as an appropriate descriptive name for this newly recognized trouble. These names "early" and "late" blight have been accepted not only by Vermont potato growers but have been generally adopted by other Experiment Station writers in the Northeastern States and Canada where these two diseases occur.

During the dry summer of 1894 and still more in 1895 our plants suffered seriously from a "blighting" which did not correspond to either of the above, and we were soon convinced that the chief cause of the premature death of the plants during that year was not the effect of "early blight" as generally thought, but was in reality lack of water, drought, combined with insect attacks.*

The dry weather of 1895 led to similar conditions which were studied with more care. An especially favorable opportunity for extended field studies was offered during a trip made by the writer in August, from Vermont through Canada to Michigan and Wisconsin returning through Indiana and New York state. Stops were made at various places along the route and the condition of the potato plants observed. The drought was severe at all points; not a healthy field of potatoes was seen on the journey. A very large proportion of the diseased condition was evidently attributable to the hot dry weather, and the most common condition of the leaves observed is described and figured a little later under the name of "Tip-burn" of the potato leaf.

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*See statement in Rep. Vt. Exp. Sta., 1894, p. 95.

The writer has had occasion in previous publications to caution potato growers against the excessive use of Paris green upon their plants.* In connection with our studies of the past summer, we have been led to the conclusion that potato leaves are injured far more generally and seriously than is commonly thought from the excessive use of this poison. In fact we are convinced from our observations that the majority of fields of early potatoes in Vermont last July and August contained great numbers of potato leaves spotted or dying from Paris green poisoning as well as from the effects of the drought and from the attacks of the early blight fungus. These three causes so widely different produce effects upon the leaves which are very similar, and we have had abundant evidence from the inquiries and specimens sent us that they are not fully distinguished even by the more observant.

In brief, then, we find at least four distinct causes for the premature dying or "blighting" of potato leaves. These causes are:

1. *The Late Blight.*
2. *The Early Blight.*
3. *Arsenical Poisoning.*
4. *Tip Burn.*

The last three of these are complicated with and increased by the attacks of insects, especially of flea beetles.

All of these troubles can be more or less completely prevented or avoided, but the measures to be taken are radically different. The first thing necessary, therefore, is a clear understanding of the cause of each trouble and ability to distinguish these various disorders from each other if more than one occurs upon the plant at the same time.

It is believed that the following descriptions and the accompanying illustrations will aid in this. In order to present the whole matter more clearly, some of the descriptions already given in this or previous bulletins are repeated.

### 1. THE LATE BLIGHT, (*or Potato Mildew and Rot*).

*Cause and Appearance.*—This is the familiar blight or "rust" which all potato growers in this State know only too well. It generally does not appear in Vermont until the moist, warm "muggy" weather of August. Occasionally, however, it begins its attack the latter part of July, and still more frequently it does little damage before the latter part of August or the first of September. The date of its appearance and the rapidity of its development are governed largely by the weather. In favorable warm rainy weather it spreads with alarming rapidity so that within a few days an entire field of luxuriant green plants becomes black and drooping, rotting with a characteristic and offensive odor. In less favoring weather its spread is slower, yet it is always rapid as compared with the diseases described later. The disease appears on the leaf as a purplish (or sometimes if dryer, brownish,) black spot which rapidly increases in size until the entire leaf is involved. Its cause is the growth of the fungus (*Phytophthora infestans, D By.*) within the leaf tissues. This fungus may often be seen on the blighting leaves as a delicate white mildew, growing from the underside of the blighting leaf. The spores or germs falling from the leaves are washed into the soil where they soon attack the tubers and lead to the familiar "rot."

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*See Rep. Vt. Exp. Sta. 1892, p. 67.

*Prevention.*—As already explained, care should be taken to plant only seed tubers free from the disease (See page 82). In addition the plants should be sprayed two or three times with the Bordeaux mixture, beginning *before the disease appears*,

### 2. THE EARLY BLIGHT (*or Leaf-Spot Disease*).

*Cause and Appearance.*—This commonly begins to show in July upon early potatoes and becomes increasingly common and destructive from that time until the plants die. Like the late blight it is caused by a fungus (*Macrosporium Solani, E. & M.*) upon the leaf. This fungus does not ordinarily attack healthy, vigorous potato leaves however, hence the destructive spread of the disease does not begin until the plants have passed their stage of greatest vigor. This ordinarily occurs soon after the blossoming period.* As this is the time when the plants are forming tubers rapidly, the inroads made by the early blight are serious and often very disastrous. This fungus does not attack the tubers directly, however, and never causes them to rot. The appearance of the leaves affected by this early blight fungus is shown in Figures 1 and 2. Figure 1 represents the early stage of the disease upon a rather young potato leaf. As will be observed at once the spots are scattered quite irregularly over this leaf yet the preference which this fungus has for places where the leaf is weakened in any way is shown by the position of several of the dead spots bordering upon or surrounding flea-beetle punctures. It should be noted, however, that the majority of these spots have no such relation to flea-beetle punctures or other mutilations and further that a majority of the flea-beetle holes have no spots bordering upon them. This illustrates the fact that the spots and holes have no necessary relation, since the fungus can penetrate the unmutilated tissue of a green leaf; also that the mutilation of the green leaf by flea-beetles or other agencies does not of itself cause the spots. This leaf was collected in the latter part of the summer. According to our observations the spots are found centering about the flea-beetle punctures more commonly in the earlier part of the season, owing doubtless to the fact that the unmutilated leaves are then vigorous enough to ward off fungus attacks. As the spots slowly enlarge the dead tissues dry and thus shrinking are thrown into peculiar folds which form broken and very irregular concentric rings, which we have described as the "target-board" markings. These markings are as yet scarcely developed in the leaf shown in Fig. 1. Their form in the older spots is well represented (though rather exaggerated) in Fig. 2. This leaf also well illustrates the fact that in an old leaf the spots are most numerous at the points of lowest vitality, viz.: at the tips and margins, or about mutilations, though they are by no means confined to these. As the spots enlarge they meet (if numerous) and fuse together soon involving large areas of the leaf, this enlargement again being most rapid in the weaker tissues. As the tissues dry the tips and margins often roll up, giving the older leaves something of the same appearance as those killed by drought in the case of "tip-burn" to be described later. This has lead to a common confusion of the two troubles, the more so since the two disorders very frequently appear on the same leaf and are mutually aggravated as will be explained in discussing the causes of "tip-burn."

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*In contrasting the early with the late blight we have stated in former reports that the early blight spreads in dryer weather than does the late blight. Our observations in 1894 and 1895 indicate that extreme drought checks the development of the early blight. Unquestionably dry hot weather by weakening the plants prepares them for the attacks of the early blight fungus, but the actual invasion of the fungus and the rapid development of the spots is favored by a fair degree of moisture. The conditions favoring this disease are therefore not prolonged drought but hot dry weather followed by a moister period.

*Prevention.* Since the serious attacks of the fungus are confined to the weakened plants steps should first be taken to increase and sustain the general vigor of the plants as far as practicable. Much can be done by the selection of vigorous varieties and by increased care in preparation, fertilization and cultivation of the soil. The date of planting should be considered also since early planted potatoes usually suffer most from the disease. But these measures can at best only delay the attacks of the fungus. As soon as the strength of the plants begins to be drained by the formation of tubers the disease may be expected. During this period, therefore, they should be thoroughly and frequently sprayed with Bordeaux mixture. Spraying has not protected our plants so completely against this early blight as it has against the late blight but it has always appeared very profitable.

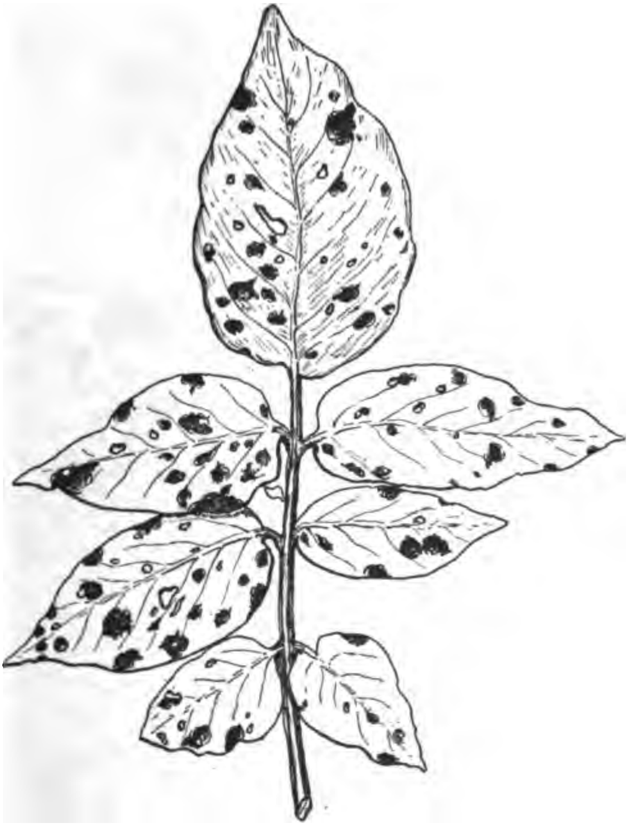

**Figure 1.** EARLY BLIGHT OF THE POTATO (Leaf-Spot Disease) in its *Early Stages* on a young leaf. Caused by the fungus *Macrosporium Solani, E. & M.* Compare with Figure 2 and see description and means of prevention on pages 91-2.

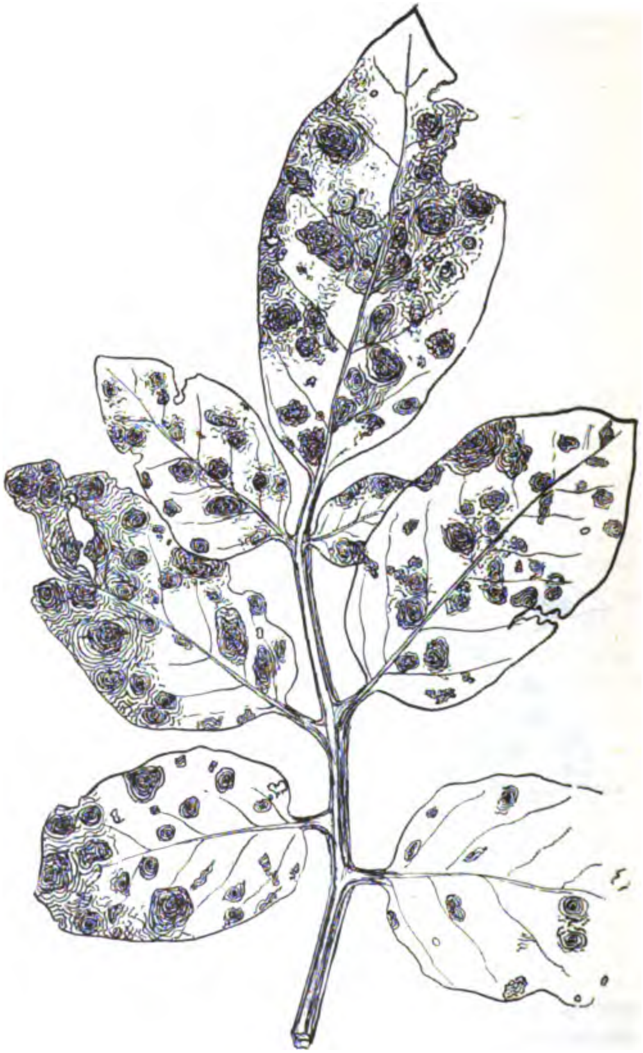

Figure 2. **EARLY BLIGHT OF THE POTATO (Leaf-Spot Disease)** in its *Later Stages* on an old leaf. The rings or "target board" markings very characteristic of such old spots are here shown more distinctly than they appear on the actual leaf. Compare with Figure 1 and see description and means of prevention on pages 91–2.

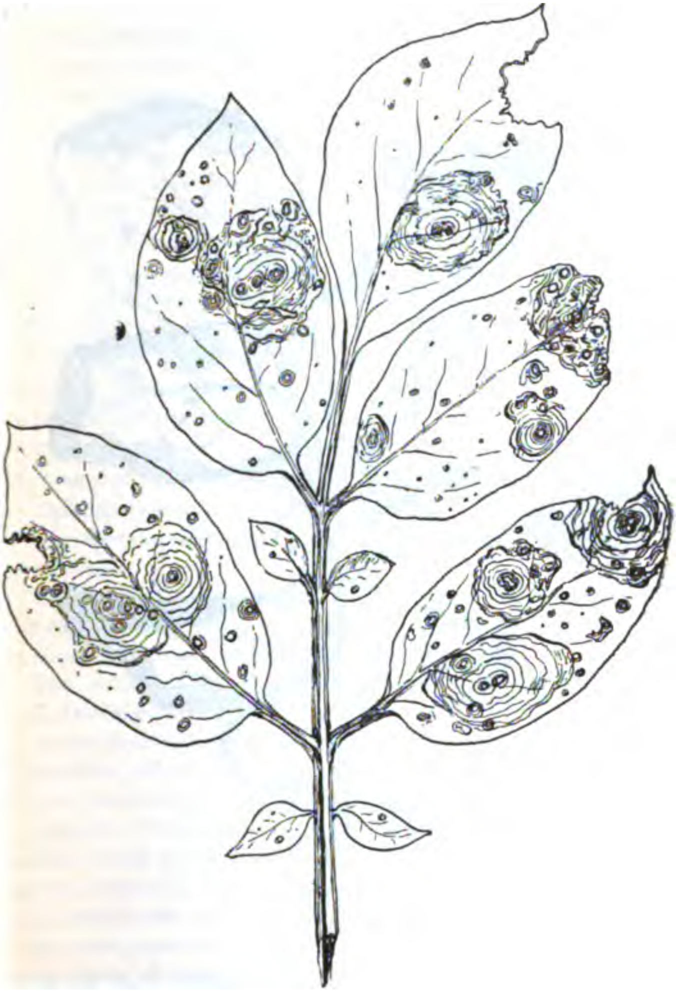

Figure 3. Arsenical Poisoning of the Potato Leaf by improper use of Paris green. The dead spots in the leaf are black or brown. Note that they all originate at flea-beetle punctures or other injuries. Compare with Figure 2 since these two troubles resemble each other so closely as to be easily confused. See description and means of prevention on page 97.

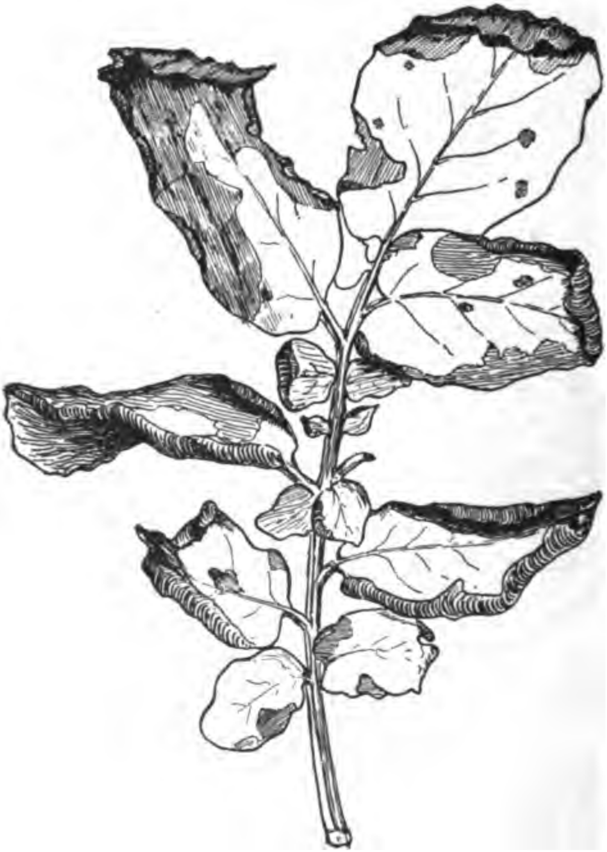

**Figure 4.** TIP BURN OF THE POTATO LEAF, due to hot, dry weather combined with any other agencies which weaken the plant. Often occurring with Early Blight and commonly confused with it. See description and means of prevention on pages 98-9.

### 3. ARSENICAL POISONING.

*Cause and Appearance.* As already stated the poisoning or "burning" of potato leaves by improper applications of Paris green is of more general occurence than is commonly supposed and the resulting injuries are frequently attributed to the "early blight" fungus. In cases of extremely strong applications of the Paris green the leaves may be entirely killed or large areas "burned" within a short time. Usually, however, its action is slower and longer continued. Its effects are then apparent as dead spots, black or brown in color, centering about flea-beetle punctures or other mutilations of the leaf. Figure 3 was drawn from such a leaf. These spots slowly continue to enlarge for some time and as a result of the slow death and drying of the tissues the surface of each spot is thrown into concentric elevations or ridges forming distinctly "ringed spots" as shown in Fig. 3. These spots so closely resemble those caused by the "early blight" fungus that they are extremely deceptive. They may usually be distinguished by the following points:

1. The spots appear soon after the application of the Paris green, and, usually, traces of the poison may be seen at the center of each spot.
2. The plants soon put out fresh leaves which remain unspotted.
3. The spots usually originate at flea-bettle punctures or other mutilations of the leaf.
4. The "target marking" made by the concentric rings are more regular and distinct, in the larger spots at least, and the distance between these rings is greater than in the typical "early blight" spots.
5. The color the spots is often a metallic black at first but usually brown in the larger spots.
6. There is no mildew or fungus growth upon the spots.

*Prevention.*—How does Paris green poison the leaf? The bulk of this poison is an insoluble powder, and being insoluble it cannot penetrate the leaf to harm it. There is a small amount of soluble arsenic present, however, and it is this which does the mischief. If Paris green is mixed with water before applying it or if the leaf is moistened by dew or rain after its surface is coated with the poison this soluble arsenic dissolves and penetrates the leaf, especially if its epidermis is freshly broken as by a flea-beetle puncture. It is for this reason that when Paris green is mixed with water alone in applying it there is more danger of its injuring the foliage than where the poison is applied dry, especially if in the latter case it is mixed with land plaster (gypsum) or some similar powder. The dry applications are therefore preferable. In cases where water is desired, however, the danger from its use may be entirely removed if lime is added to the mixture, the lime serving to neutralize the soluble arsenic. In preparing this lime mixture, place the Paris green together with about an equal weight of fresh stone lime in a pail of hot water, mix them thoroughly as the lime slacks and allow the mixture to stand a couple of hours before applying. One pound of Paris green prepared in this way added to 100 gallons of water is strong enough to destroy the potato beetles. During the latter part of the season the Paris green may be added directly to the Bordeaux mixture in the same proportion.

### 4. TIP-BURN.

*Cause and Appearance.* The disease we term "tip-burn" is characterized by the death of the potato leaves at their tips and margins, which portions dry, blacken and roll up or break off. The appearance of the diseased leaves is well illustrated in Fig. 4. This trouble has occurred quite commonly in Vermont during the dry hot weather of mid-summer in 1894 and 1895, and as before stated it was observed to a worse degree in Michigan, and Wisconsin where the drought was more severe. In its earlier stages the dead tissues are often quite free from invasion by fungi, and even in the advanced stages the fungi present *are chiefly saprophytes i.e., such as live upon dead plant tissue only.

Tip-burn is not caused by the attacks of parasitic fungi. It is rather attributable to the unfavorable conditions surrounding the plant,

*By this we mean the fungi present upon the dead tissues at the tips or margins of the leaves. There may be and frequently are early blight spots upon the leaves suffering from tip burn, especially when the two diseases reach their advanced stages in the latter part of the season. As before stated the early blight fungus is quick to establish itself upon the weakened portions of the leaves, hence if it is present on the plants suffering from tip-burn it often attacks the weakening tips of the leaves and so hastens their destruction. Moreover the early blight fungus is capable of living as a saprophyte upon the dead tissues of potato leaves and doubtless often appears in this role first upon these dead margins, but once thoroughly established it invades the green tissues adjoining. The saprophytic fungi almost invariably found upon these dead tissues are a species of *Cladosporium* and of *Alternaria*. The latter is characterized by the production of its spores in chains. The detached spores of this Alternaria resembles so closely those of the *Macrosporium Solani*, however, that we were considerably puzzled by them until we secured them in pure cultures. They were then clearly distinguished by their appearance and mode of growth. In artificial inoculations made by placing spores from these cultures upon potato leaves, we have been unable to get the Alternaria to penetrate living potato leaves, whereas, when the Macrosporium spores were placed upon similar leaves the characteristic early blight spots appeared in a few days. We conclude, therefore, that the two fungi, although so closely resembling each other, are distinct species and that the Macrosporium is a parasite while the Alternaria is a saprophyte. We have been unable to establish the identity of this Alternaria with any of the described species, but hesitate to publish it as a new species until we have had opportunity for more thorough examination of some of these others. If it proves distinct we shall propose the name *Alternaria decipiens* for it.

especially to the dry hot weather with insufficient water supply.* It is aggravated by any other conditions which tend to lower the general vigor of the plant, such as insufficient food supply, and attacks of insects and the early blight fungus. This difficulty has not been observed to any serious degree upon plants until after they pass the blossoming period, and naturally begin to weaken.

As the older leaves weaken, especially the lower leaves of the plants, the tissues of the interior of the leaf sometimes develops dead spots surrounding flea beetle punctures or other injuries. These spots soon dry and show distinct rings and bear a general resemblance to the "ringed spots" caused by Paris green and by the early blight fungus. They may occur, however, in the absence of both these causes. Dr. Sturgis, describing these spots in his Report for 1894, attributed them to the effects of dry, hot weather. We believe this to be the correct explanation and would therefore associate them with "tip-burn" rather than with the true "early blight."

*Prevention.*—Effort should be made to increase and sustain the general vigor of the plant by proper selection of varieties, preparation and cultivation of the soil, and protection against the attacks of insects and fungi. The only thing that can be done in addition is to irrigate in times of extreme drought. So far as we know irrigation of potatoes is not practiced in Vermont, at least outside of small garden plots. We have seen marked benefits from watering such garden plots. In the Western States, notably in Colorado, immense crops of potatoes are raised upon irrigated land. Irrigation is successfully practiced by market gardeners in the vicinity of Boston and New York, and is being tried by one of the largest orchardists of Connecticut. Trial alone can demonstrate whether it is profitable to irrigate potatoes in Vermont, but it certainly cannot be doubted that irrigation would do much to increase the value of the crop some years, as in 1894, and would add something to it every year.

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*Dr. W. C. Sturgis of the Connecticut Experiment Station in his Annual Report for 1894, p. 129, expresses the opinion that "extreme heat and dryness accentuated by lack of moisture in the soil may induce the death of tissues at a distance from the roots (the tips and edges of the leaflets)." Mr. E. G. Lodeman in Bulletin 113, New York (Cornell) Experiment Station, p. 258, received just as this is going to press, describes what appears to be this disease as it occurs in his State and says that "potatoes grown upon dry soils, which are naturally warm and 'quick,' are more subject to the disease than those grown in moister places in the same field. * * * Water seems to be the one thing most needed."

## V. FROST INJURIES TO APPLES AND PEARS.

The following letter sent to the Experiment Station from Vergennes, Vt., under date of August 13, 1895, is typical of a number of inquiries received last summer and autumn :

> "We send you to-day samples of apples showing a diseased condition which has attacked our fruit for the first time. We should like to learn if it is a new trouble and what can be done to prevent it. It has attacked all kinds of apples, but is worst on the Greenings. It starts as a small spot and spreads, often covering the entire apple, the growth being checked by it. It seems to be worse on the east side of the trees. The rapidity with which it has spread in the last ten days causes us to fear that it will injure the sale of the fruit. Can we do anything to stop it this year and how shall we check its return another year." J. W. R.

The skin of the apples received was badly russeted over the surface from one-third to one-half the distance back from the apex toward the stem. On some the russeted area formed a band or zone extending partially or entirely around the apple midway between apex and stem. The injury was even more common on the pears brought from about Burlington into the city markets than it was upon apples. Fig. 5 is from a photograph of an injured Bartlett pear, showing a characteristic russet band.

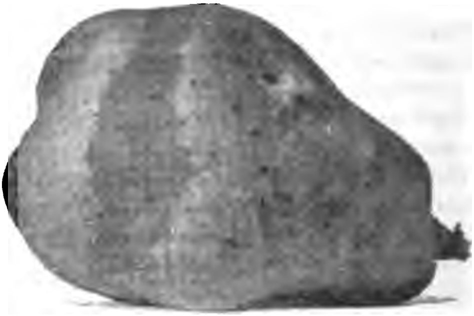

Fig. 5. A Bartlett pear showing frost injury.

Many fruit growers attributed the russeting to injury from solutions used in spraying them, yet on inquiry it was found that unsprayed trees suffered equally with sprayed ones. The injury was unquestionably due to a late frost. Similar injury was observed by the writer upon fruit in Canada, New York State and as far west as Wisconsin,

Mr. G. H. Powell of Cornell University writing in *Garden and Forest*, Vol. VIII, p. 417, regarding the trouble says it is due to the freezing of the dew collected upon the young fruit and adds that "it is interesting to note that the cells in the frosted zones multiply and produce cells of their own kind, thus increasing the width of the zone during the growing period."

# INFORMATION WANTED!

**A BAD WEED.** The "paint-brush" or "hawk weed" is a dangerous weed which is rapidly spreading in Vermont. It bears on a naked stem about one foot high a cluster of handsome orange red flowers, each nearly the size of a silver quarter of a dollar. The leaves lie in a rosette at the base of the stem and are covered with rough hairs.

We wish to learn in what parts of the State this weed has already established itself, as well as the means employed by those who have succeeded in eradicating it. Our own experiments thus far indicate that salt kills it out quickly and thoroughly, and we should especially like to learn the experience of others with this material. Statements or inquiries regarding this or any other new or troublesome weed are invited.

**AN ONION DISEASE.** For some years occasional complaints of onion leaf blights or rusts have been received by us, but always after the plants were dead. A more timely call last September, followed by prompt investigation, showed the presence, in this case at least, of the onion "mildew," a fungus disease which attacks the leaf. The diseased leaf soon becomes covered with a gray mildew, dies, withers and blackens from the tip. So far as observed the bulbs were not affected. Experiments with remedies will be undertaken in 1896. Meanwhile onion growers who have had serious trouble with this disease are requested to write us stating locality, weather conditions favorable to its development, varieties most liable to attack, any experience with preventive measures, etc. In case of doubt regarding the nature of this or any other plant disease, affected leaves or other parts may be mailed to the Station.

1896.

## VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 50.

MARCH, 1896.

## Analyses of Commercial Fertilizers.

I. Statement Regarding Analyses. (Page 3.)
II. Schedule of Trade Values. (Pages 3–6.)
III. Observance of the Fertilizer Law. (Page 6.)
IV. Licensed Fertilizers Sampled by Station. (Pages 6–7.)
V. Analyses of Licensed Fertilizers. (Page 8.)

BURLINGTON:
FREE PRESS ASSOCIATION,
1896.

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*Connected with Fertilizer Control.

# BULLETIN NO. 50, ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills and B. O. White.

## I. STATEMENT REGARDING ANALYSES.

The present bulletin contains an analysis of a composite sample (mixture of equal portions of several samples taken from different parts of the State) of a leading brand of goods of each manufacturer licenced to sell in Vermont, excepting the Henry F. Tucker Co., Read Fertilizer Co. and Lowell Fertilizer Co. These are not included as no samples of their brands have as yet been found by our sampling agents. The choice of brand for immediate analysis is based largely upon the frequency with which it has been found in the search for samples during the past two seasons.

A second bulletin of analyses will be issued about the middle of April, in which it is expected to include all the brands most commonly sold in the State. A third will be issued in May and will contain the analyses of the brands less widely used.

All samples are taken by agents of the Experiment Station from the stocks of local dealers and represent therefore exactly what the purchaser is getting.

For detailed data regarding the meaning of the terms used in fertilizer analysis, the sources of crude stock, the commercial and agricultural values of fertilizers, and the principles underlying the rational and economical selection, purchase and use of fertilizers, the reader is referred to Bulletin 47 of this Station which will be sent to any address upon application.

## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this State, in 1896, is the one agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut and New Jersey, after a careful study of prices ruling in the large markets of the New England and Middle States:

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1895 AND 1896.

| | 1895. cts. per lb. | 1896. cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 18½ | 15 |
| " in nitrates | 15 | 13½ |
| Organic nitrogen in dried and fine ground fish, blood and meat and in high grade mixed fertilizers | 16 | 14 |
| " " in cotton seed meal | 12 | 12 |
| " " in fine ground bone and tankage | 16 | 13½ |
| " " in fine medium " " | 14 | 12 |
| " " in medium " " | 11 | 9 |
| " " in coarse " " | 5 | 8 |
| " " in horn shavings, hair and coarse fish scrap | 5 | 8 |

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*No. 49, on Potato Fungi and Fungicides is in preparation and will be issued shortly.

| | | |
|---|---|---|
| Phosphoric acid soluble in water | 6 | 5½ |
| " " " in ammonium citrate* | 5½ | 5 |
| " " " in fine ground fish, cotton seed meal, and wood ashes | 5 | 4½ |
| " " in dry fine ground fish and in fine bone and tankage | 5½ | 5 |
| " " in fine medium bone and tankage | 4½ | 4 |
| " " in medium " " | 3 | 2½ |
| " " in coarse " " | 2 | 2 |
| " " insoluble (in ammonium citrate) " " in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate (or chlorids) | 5½ | 5 |
| Potash as muriate | 4½ | 4½ |

The above trade values are the average figures at which in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st, plus about 20 per cent, in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable retail price in the large markets of standard raw materials such as, Sulphate of Ammonia, Nitrate of Soda, Muriate of Potash, Sulphate of Potash, Dried Blood, Plain Superphosphate, Azotin, Dry Ground Fish, Ammonite, Cotton Seed Meal, Bone, Tankage and Ground South Carolina or Florida Rock.

### APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS.

The above trade values are applied to the valuation of superphosphates and all mixed goods as follows :

The organic nitrogen is valued at 14 cents per pound, it being assumed that it is obtained from such materials as dried blood, tankage, cotton seed meal, ground fish or nitrogenous substances of equally good quality.

Nitrogen in the form of nitrate of soda and sulphate of ammonia is valued at 13½ and 15 cents per pound respectively.

Soluble, reverted and insoluble phosphoric acid in mixed fertilizers are valued at 5½, 5 and 2 cents per pound respectively.

The potash is valued at 4½ cents per pound, the price of that ingredient in kainit and muriate if there is sufficient chlorin in the fertilizer to unite with all the potash ; if not, such as is not thus united is valued at 5 cents per pound, the price of that ingredient in high grade sulphate.

The " Station valuation" of a fertilizer may be obtained by *multiplying the given per cent of each constituent (nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.* Van Slyke† gives the following simple rule for calculating the approximate "Station valuation" of a commercial fertilizer. *Multiply the per cent of nitrogen by three and add to the product the figures representing the per cents of available phosphoric acid and of potash.* The sum expresses in dollars and cents the approximate Station valuation.

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*Dissolved from 2 grams of the unground phosphate, previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes at 65 degrees C., with agitation once in five minutes ; commonly called "reverted," or "backgone" phosphoric acid.

†N. Y. Ag'l. Expt. Station, Bulletin 94, p. 386.

As **these estimated values are not intended to represent the proper selling price of mixed goods at the point of consumption,** and in order to prevent any possible misapprehension as to their real meaning, the following explanations are offered :

1. These trade values represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, in their various forms, can now be purchased, for cash at retail in our large markets. They are based mostly upon the ton prices at which certain classes of goods are offered to actual consumers.

2. These trade values do not include the charges for transportation from the market to the consumer, for storage, mixing, commissions to agents and dealers, selling on long credit, bad debts, etc., etc.

3. They are the prices of nitrogen, phosphoric acid and potash, *ready for use by the farmer*, when these ingredients are purchased under the above named conditions, singly and not mixed. In ordinary superphosphates we find these three ingredients mixed, but this not a necessary condition of their use.

An illustration may serve to make clear the above statements. A farmer wishes a ton of fertilizer similar to the well-known brands sold in this State. If he purchases for cash in New York or Boston, fifty (50) pounds of nitrate of soda, three hundred and fifty (350) pounds of dried blood, one hundred and twenty five (125) pounds of muriate of potash and fourteen hundred and seventy five (1475) pounds of dissolved South Carolina rock, known in the trade as "acid phosphate," and mixes these ingredients together, he will have a complete fertilizer analysing very closely like the average goods sold in Vermont in 1895, and not essentially different from many standard brands now in the market.

. The cost of the ton after mixing (if the farmer prefers to mix the ingredients) will be made up as follows :

(*a*) Cost of the materials in the markets.
(*b*) Cost of transportation.
(*c*) Cost of mixing.

The first item entering into the total cost is the only one included in the "valuation." If there is added to this one item not only the charges for transportation and mixing but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary superphosphates, when delivered at or near the place of consumption.

4. The Station valuations stand in no direct or necessary relation to the comparative profits which may be derived from the use of various fertilizers by individual farmers. These values have an almost purely commercial significance, and are not designed to point out to a farmer whether he shall use potash, which is comparatively a cheap ingredient, or nitrogen, which is comparatively costly.

For further information concerning fertilizer analyses and for an explanation of the meaning of the terms employed, the reader is referred to the previous reports and bulletins of the Station (particularly No. 47) which will be sent to any address upon application.

## III. OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law :

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1. | Pacific Guano Co | Boston, Mass. |
| 2. | Quinnipiac Co | Boston, Mass. |
| 3. | Bradley Fertilizer Co | Boston, Mass. |
| 4. | Cleveland Dryer Co | Cleveland, O. |
| 5. | Lister's Agricultural Chemical Works | Newark, N. Y. |
| 6. | Crocker Fertilizer and Chemical Co | Buffalo, N. Y. |
| 7. | Standard Fertilizer Co | Boston, Mass. |
| 8. | Cumberland Bone Phosphate Co | Portland, Me. |
| 9. | Bowker Fertilizer Co | Boston, Mass. |
| 10. | E Frank Coe Co | New York, N. Y. |
| 11. | Williams & Clark Co | New York, N. Y. |
| 12. | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13. | Clarks Cove Fertilizer Co | Boston, Mass. |
| 14. | Henry F. Tucker Co | Boston, Mass. |
| 15. | Read Fertilizer Co | New York, N. Y. |
| 16. | Lowell Fertilizer Co. | Lowell, Mass. |

## IV. LICENSED FERTILIZERS SAMPLED BY STATION.

### Bowker Fertilizer Co., Boston, Mass.

**1644. Corn Phosphate** ; from stocks of J. L. Grant, East Berkshire ; A. L. Aseltine, Swanton.

### Bradley Fertilizer Co,, Boston, Mass.

**1688. Corn Phosphate** ; from stocks of Brooks and Berry, Montpelier ; D. A. Spooner, Randolph ; G. H. Tupper, Bethel ; Clark and Chandler. Bradford ; H. N. Gray, Cambridge ; H. M. Maxfield, Johnson ; Geo. Shorey, Lyndonville ; W. C. Trombly, Barton Landing.

### Clark's Cove Fertilizer Co., Boston, Mass.

**1745. Bay State Fertilizer, G. Grade**; from stocks of A. A. Olmstead, South Newbury ; W. B. D. Avery, Bradford.

### Cleveland Dryer Co., Cleveland, O.

**1689. Potato Phosphate** ; from stocks of R. D. Stuart, Berlin ; D. A. Spooner, Randolph ; M. M. Whipple, Bethel ; S. H. Warren, Hardwick.

### E. Frank Coe Co., New York, N. Y.

**1690. Columbian Corn Fertilizer**; from stocks of J. E. Foss, Hardwick ; E. S. Stratton & Son, Craftsbury ; Farnham and Allbee, St. Johnsbury ; J. B. Adams, Randolph.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**1691. Potato, Hop and Tobacco Phosphate**; from stocks of Fred Fuller, East Montpelier ; R. Brush, Cambridge ; G. I. H. Smith, Morristown ; J. B. Freeman, Barton.

### Cumberland Bone Phosphate Co., Portland, Me.

**1713. Superphosphate**; from stocks of W. H. Nye & Co., Johnson ; W. F. Clark, Glover ; Chas. Gates & Sons, North Hartland.

### Great Eastern Fertilizer Co., Rutland, Vt.

**1746. Corn Phosphate** ; from stock of P. W. Currier, Berlin ; J. C Wright, North Hartland.

### Lister's Agricultural Chemical Works, Newark, N. J.

**1614. Success Fertilizer** ; from stocks of John Hodges, Randolph ; T. J. Gagner, St. Johnsbury ; F. Churchill, Barton Landing.

### Pacific Guano Co., Boston, Mass.

**1747. Soluble Pacific Guano** ; from stocks of R. B. Rixley, Norwich; C. P. Stevens, Walden.

### Quinnipiac Co., Boston, Mass.

**1715. Corn Manure** ; from stocks of H N. Gray, Cambridge ; Ely Wells, South Woodbury ; Brown and Skinner, Barton Landing ; F. W. Pierce, Fairlee.

### Standard Fertilizer Co., Boston Mass.

**1737. Fertilizer** ; from stock of C. W. Atherton, Waterbury.

### Williams and Clark Fertilizer Co., New York, N. Y.

**1692. Americus Corn Phosphate**; from stocks of M. E. Bailey, Berlin ; C. L. Sanders, Bethel ; J. L. Kinery, Windsor ; A. Carpenter, Cambridge ; F. H. Percivill, Glover.

## V. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| 1744 | Bowker's Corn Phosphate... | 0.58 | .... | 1.35 | 1.93 | 1.5 | $5.35 | 5.35 | 3.42 | 2.80 | 11.57 | 11. | 8.77 | 9 | $10.43 | 2.41 | 2. | $2.17 | 1744 |
| 1688 | Bradley's Corn Phosphate... | 0.57 | .... | 1.66 | 2.23 | 2.0 | 6.19 | 4.96 | 3.88 | 2.90 | 11.74 | 10. | 8.84 | 9. | 10.50 | 1.72 | 1.5 | 1.55 | 1688 |
| 1745 | Clark's Cove Bay State. G. G. | .... | 0.16 | 2.07 | 2.23 | 1.85 | 6.28 | 4.38 | 4.01 | 2.67 | 11.06 | 11. | 8.39 | 8.5 | 9.90 | 2.19 | 2. | 1.97 | 1745 |
| 1689 | Cleveland's Potato Phosphate | 0.40 | 0.18 | 1.68 | 2.26 | 2.05 | 6.32 | 5.03 | 2.93 | 3.26 | 11.22 | 9. | 7.96 | 8. | 9.76 | 3.00 | 3. | 2.70 | 1689 |
| *1690 | Coe's Columbian Corn Ferti'z'r | .... | .... | 1.90 | 1.90 | 1. | 5.32 | 6.59 | 2.05 | 3.05 | 11.69 | 11. | 8.64 | 9. | 10.52 | 2.24 | 1.85 | 2.20 | 1690 |
| 1691 | Crocker's Pot'o, Hop & Tob. Phs | ... | 0.11 | 2.03 | 2.14 | 2. | 6.01 | 7.10 | 3.03 | 1.04 | 11.17 | 11. | 10.13 | 10. | 11.26 | 3.56 | 3.25 | 3.20 | 1691 |
| 1718 | Cumberland Superphosphate | 0.12 | 0.15 | 2.00 | 2.28 | 2.06 | 6.40 | 5.53 | 2.49 | 2.65 | 10.67 | 10. | 8.02 | 8. | 9.62 | 2.36 | 2. | 2.12 | 1718 |
| 1746 | Great Eastern Corn Phosph'te | 0.30 | 0.14 | 2.41 | 2.85 | 3. | 7.98 | 6.63 | 1.97 | 1.40 | 10.00 | 9. | 8.60 | 8. | 9.82 | 2.29 | 2. | 2.06 | 1746 |
| 1714 | Lister's Success Fertilizer... | .... | 0.21 | 1.37 | 1.58 | 1.23 | 4.47 | 8.25 | 1.23 | 2.80 | 12.28 | 11.5 | 9.48 | 9. | 11.43 | 2.21 | 2. | 1.99 | 1714 |
| 1747 | P.G. Co's Soluble Pacific. Gu. | 0.34 | 0.15 | 1.72 | 2.21 | 2.25 | 6.19 | 5.68 | 3.68 | 2.13 | 11.49 | 10.5 | 9.36 | 8.5 | 10.77 | 2.37 | 2. | 2.13 | 1747 |
| 1715 | Quinnipiac Corn Manure.... | 0.29 | 0.14 | 1.81 | 2.33 | 2.06 | 6.51 | 4.56 | 3.96 | 2.63 | 11.15 | 10. | 8.52 | 9. | 10.03 | 1.52 | 1.5 | 1.37 | 1715 |
| 1787 | Standard Fertilizer......... | 0.41 | 0.15 | 1.62 | 2.18 | 2. | 6.09 | 6.19 | 2.67 | 2.03 | 10.89 | 10. | 8.86 | 8. | 10.29 | 2.33 | 2. | 2.10 | 1787 |
| 1692 | W.&C. Co's Am. Corn Phos'te | 0.31 | 0.16 | 1.83 | 2.30 | 2.06 | 6.44 | 4.60 | 3.61 | 3.29 | 11.50 | 10. | 8.21 | 9. | 9.99 | 1.59 | 1.5 | 1.43 | 1692 |

* Potash in this brand is in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all the potash as such.

1896.

# VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 51.

APRIL, 1896.

## Analyses of Commercial Fertilizers.

I. STATEMENT REGARDING COLLECTION OF SAMPLES. (Pages 11-12.)
II. LICENSED FERTILIZERS SAMPLED BY STATION. (Pages 12-14.)
III. ANALYSES OF LICENSED FERTILIZERS. (Pages 15-17.)
IV. BRANDS NOT REPORTED IN THIS BULLETIN. (Pages 18-19.)

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# BULLETIN No. 51, ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills and B. O. White.

## I. STATEMENT REGARDING COLLECTION OF SAMPLES.

During February, March and early April, Messrs. C. F. Clark of Glover, W. C. Perry of Burlington, and A. M. Vaughan of Woodstock, agents of this Station, visited 80 towns and villages in Vermont and drew 316 samples, representing 102 distinct brands of fertilizers. Ninety-two brands were found last year, 58 in 1894, and but 36 in 1893. This rapid increase is partly due to an actual increase in the number of brands sold and partly to our inability to make a thorough search in earlier years, owing to causes explained in Bulletin 45.

It is believed that one or more samples of nearly every brand of fertilizer sold in the State has been secured this spring. The Station desires that farmers, farmers' clubs and granges call its attention to brands of fertilizers on sale not included in this bulletin, either in the tables of analyses or the list of samples on hand. So far as is practicable goods thus reported will be sampled. It should be noted, however, that, as a rule, the Station will not sample or analyse

1. From stock of less than one ton.
2. From stock which has lain over from a former season.
3. From stock which has been improperly stored.

Bulletin 50, distributed to the State mailing list March 25th, contained an analysis of a composite sample of a leading brand of goods of each manufacturer selling in this State, excepting the Lowell Fertilizer Co., the Read Fertilizer Co. and the Henry F. Tucker Co., none of whose goods had at that time been found by us. The present bulletin contains the analyses of composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the State) of 50 distinct brands, the out-put of fourteen manufacturers. The composite sample certainly represents the average character of the goods more fairly than can the analysis of a single sample. The thirteen analyses published in bulletin 50 are reprinted in this bulletin to facilitate ready reference.

The 50 brands reported comprise all those of which three or more samples were found by the Station agents. There is reason to believe that fully nine-tenths of the trade in the State is confined to these brands.

The reader is referred to Bulletin 50 for the schedule of trade values and their application to superphosphates and mixed goods. It should be particularly noted, however, that **these trade values do not represent the proper selling prices of mixed goods at the point of consumption,** but are the retail cash prices of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commission, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance.

The reader is also referred to Bulletin 47 for a full discussion of the principles and practice of fertilization, with suggestions concerning the selection, purchase and use of artificial fertilizers, and especially to the remarks on home mixing.

This as well as other bulletins and reports will be sent to any address without charge, on application.

## II. LICENSED FERTILIZERS SAMPLED BY THE STATION.

### Bowker Fertilizer Co., Boston, Mass.

**1970. Farm and Garden Phosphate**; from stocks of W. H. McAllister, Enosburgh Falls; W. S. Holland, Townshend; A. E. Fuller, Woodstock.

**1963. Hill and Drill Phosphate**; from stocks of A. L. Aseltine, Swanton; H. B. Martin, Bradford; L. F. Fortney, Plainfield.

**1966. Potato Phosphate**; from stocks of A. L. Aseltine, Swanton; J. L. Grant, East Berkshire; W. S. Holland, Townshend; H. B. Martin, Bradford; L. F. Fortney, Plainfield.

**1977. Stockbridge Corn Manure**; from stocks of L. F. Fortney, Plainfield; C. E. Perry, Williamsville; Edwards & Grout, Newfane.

**1959. Stockbridge Potato Manure**; from stocks of C. M. Strong, Hyde Park; C. G. & H. F. Leach, Pawlet; Geo. A. Wales, South Barre.

**1965. Sure Crop Phosphate**; from stocks of W. S. Holland, Townshend; Rumsey & St. John, Castleton; W. H. McAllister, Enosburgh Falls; Isaiah Benson, West Woodstock.

**1964. Vermont Phosphate**; from stocks of C. M. Strong, Hyde Park; L. F. Fortney, Plainfield; Geo. A. Wales, South Barre.

### Bradley Fertilizer Co., Boston, Mass.

**1748. Eclipse Phosphate**; from stocks of Geo. Storey, Lyndonville; Sherman & Brady, Newport; H. A. Pond, East Berkshire; W. C. Twombly, Barton Landing; H. M. Maxfield, Johnson; Brooks & Berry, Montpelier; D. A. Spooner, Randolph; G. T. Tupper, Bethel; Clark & Chamberlain, Bradford.

**1967. Patent Superphosphate of Lime**; from stocks of D. A. Spooner, Randolph; Brooks & Berry, Montpelier; Clark & Chamberlain, Bradford.

**1749. Potato Fertilizer**; from stocks of H. A. Pond, East Berkshire; Sherman & Brady, Newport; W. C. Twombly, Barton Landing; Geo. Storey, Lyndonville; W. W. Coe, West Burke; H. M. Maxfield, Johnson; D. A. Spooner, Randolph; G. F. Tupper, Bethel,

1750. **Potato Manure**; from stocks of H. N. Gray, Cambridge; H. A, Pond, East Berkshire; Brooks & Berry, Montpelier; Clark & Chamberlain, Bradford.

1751. **X. L. Superphosphate of Lime**; from stocks of H. A. Pond, East Berkshire; Geo. Storey, Lyndonville; Sherman & Brady, Newport; W. W. Coe, West Burke; H. W. Gray, Cambridge; Brooks & Berry, Montpelier; D. A. Spooner, Randolph; G. F. Tupper, Bethel; Clark & Chamberlain, Bradford.

### Cleveland Dryer Co., Cleveland, O.

1957. **Corn and Grain Phosphate**; from stocks of S. H. Warren, Hardwick; M. M. Whipple, Bethel; S. C. Wheeler, Waterbury.

1752. **Fertilizer for All Crops**; from stocks of W. H. Dunton, Sheldon Junction; D. A. Spooner, Randolph; M. M. Whipple, Bethel.

### E. Frank Coe Co., New York, N. Y.

1972. **Ammoniated Bone Superphosphate**; from stocks of A. Bemis, Marshfield; Martin Lee, Castleton; G. H. Dunn, Pownal; Edwards & Grant, Newfane,

1753. **Columbian Potato Fertilizer**; from stocks of E. S. Stratton & Son, Craftsbury; Farnham & Allbee, St. Johnsbury; Walter Phelps, Enosburgh Falls.

1971. **Grass and Grain Fertilizer**; from stocks of S. F. Strong & Son, Lyndonville; W. Simonds, North Bennington; Geo. H. Dunn, Pownal; F. R. Button, Brandon.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

1968. **Ammoniated Bone Superphosphate**; from stocks of Fred Fuller, East Montpelier; G. W. Gillis, Danville; C. D. Hill, West Concord.

1755. **Ammoniated Corn Phosphate**; from stocks of R. Brush, Cambridge; G. I. H. Smith, Morrisville; J. B. Freeman, Barton; O. G. Phelps, Milton; Fred Fuller, East Montpelier.

1754. **New Rival Ammoniated Superphosphate**; from stocks of R. Brush, Cambridge; J. B. Freeman, Barton; O. G. Phelps, Milton.

1978. **Superior Rye and Oats Phosphate**; from stocks of F. R. Button, Brandon; Rumsey & St. John, Castleton; Beecher Bros., West Pawlet.

### Cumberland Bone Phosphate Co., Portland, Me.

1757. **Fertilizer**; from stocks of W. H. Nye & Co., Johnson; W. F. Clark, Glover; M. L. Kendall, Enosburgh Falls; Chas. Gates & Sons, North Hartland.

1756. **Potato Fertilizer**; from stocks of W. H. Nye & Co., Johnson; W. F. Clark, Glover; M. L. Kendall, Enosburgh Falls.

### Great Eastern Fertilizer Co., Rutland, Vt.

**1973. General Fertilizer**; from stocks of C. B. Whitney, Barnet; H. F. Hardy, Richford; M. H. Jewett, Swanton; J. C. Wright, North Hartland; H. Gates, Ludlow.

**1956. Grass and Oats Fertilizer**; from stocks of G. H. Burton, Wells; J. C. Wright, North Hartland; P. W. Currier, Berlin.

**1969. Potato Manure**; from stocks of J. C. Guthrie, Peacham; J. C. Wright, North Hartland; P. W. Currier, Berlin.

### Lister's Agricultural Chemical Works, Newark, N. J.

**1974. Animal Bone and Potash**; from stocks of J. E. Buttolph, Middlebury; R. J. Maranville, Wallingford; Wm. Valentine, Tinmouth.

### Pacific Guano Co., Boston, Mass.

**1958. Special Potato and Tobacco Fertilizer**; from stocks of F. A. Sheldon & Bro., Rupert; E. Walbridge, North Bennington; W. F. Clark, Glover; R. B. Rixley, Norwich.

### Quinnipiac Co., Boston, Mass.

**1758. Climax Phosphate**; from stocks of G. D. Butler, East Montpelier; C. P. Rhoades, Richmond; Ely Wells, South Woodbury.

**1759. Potato and Tobacco Fertilizer**; from stocks of H. N. Gray, Cambridge; Ely Wells, South Woodbury; C. P. Rhoades, Richmond.

### Read Fertilizer Co., New York, N. Y.

**1976. Farmers' Friend Superphosphate**; from stocks of Perry Porter, West Burke; H. S. Warner, Ludlow; J. L. McCaul, Bennington.

**1975. Fish, Bone and Potash**; from stocks of J. L. McCaul, Bennington; M. D. Park, St. Johnsbury Center; A. J. Lyon, West Concord.

**1960. Leader Guano**; from stocks of J. L. McCaul, Bennington; W. H. Sampliner, Bakersfield; M. A. Hoadley, Waterbury.

**1961. Practical Potato Special**; from stocks of Wilbur Newton, Essex Center; W. H. Sampliner, Bakersfield; J. L. McCaul, Bennington: M. A. Hoadley, Waterbury.

**1962. Standard Superphosphate**; from stocks of V. A. Patch, Johnson; Wilbur Newton, Essex Center; M. A. Hoadley, Waterbury.

### Williams & Clark Co., New York, N. Y.

**1760. Americus Potato and Tobacco Phosphate**; from stocks of A. Carpenter, Cambridge; F. H. Percevill, Glover; Martin & Simpkins, Enosburgh Falls; Wm. Prentiss, Milton; M. E. Bailey, Berlin; J. H. Kinery, Windsor.

**1761. Royal Bone Phosphate**; from stocks of M. E. Bailey, Berlin; J. H. Kinery, Windsor; A. Carpenter, Cambridge; Martin & Simpkins, Enosburgh, Falls.

## III. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| †1744 | Bowker's Corn Phosphate | 0.58 | .... | 1.35 | 1.93 | 1.5 | $5.35 | 5.85 | 3.42 | 2.80 | 11.57 | 11. | 8.77 | 9 | $10.43 | 2.41 | 2. | $2.17 | 1744 |
| 1970 | " Farm & Garden Phos. | 0.48 | .... | 1.39 | 1.87 | 1.6 | 5.19 | 5.09 | 3.40 | 2.75 | 11 24 | 10. | 8.49 | 8 | 10.10 | 2.37 | 2. | 2.13 | 1970 |
| 1963 | " Hill & Drill Phos | 0.77 | 0.13 | 1.61 | 2.51 | 2.5 | 6.98 | 8.12 | 2.37 | 1.74 | 12.23 | 12. | 10.49 | 9 | 12.00 | 2.46 | 2. | 2.21 | 1963 |
| 1966 | " Potato Phosphate | 0.46 | .... | 1.30 | 1.76 | 1.5 | 4.88 | 4.96 | 3.85 | 3.14 | 11.95 | 10. | 8.81 | 8 | 10.56 | 2.45 | 2. | 2.20 | 1966 |
| 1977 | " Stockb'ge Corn Manure | 1.26 | .... | 2.36 | 3.62 | 3.25 | 10.01 | 7.88 | 2.11 | 1 90 | 11.89 | 10. | 9.99 | 8 | 11.54 | 4.51 | 4. | 4.06 | 1977 |
| 1959 | " " Potato " | 1.26 | 0.14 | 1.77 | 3.17 | 3.25 | 8.78 | 3.29 | 2.39 | 2.85 | 8.53 | 8. | 5.68 | 5 | 7.15 | 9.71 | 10. | 8.74 | 1959 |
| 1965 | " Sure Crop Phosphate. | 0.31 | ... | 0.83 | 1 14 | 0.75 | 3.16 | 6.09 | 3.88 | 2.76 | 12.73 | 10. | 9.97 | 8 | 11.68 | 1.28 | 1. | 1.15 | 1965 |
| 1964 | " Vermont Phosphate | 0.50 | 0.27 | 1.77 | 2 54 | 2.06 | 7.12 | 8.20 | 2.62 | 1.42 | 12 24 | 10. | 10.82 | 8 | 12.21 | 4.71 | 3. | 4.24 | 1964 |
| ‡1688 | Bradley's Corn Phosphate | 0.57 | .... | 1.76 | 2.33 | 2. | 6.47 | 4.96 | 3.95 | 2.90 | 11.81 | 10. | 8.91 | 9. | 10.58 | 1.72 | 1.5 | 1.55 | 1688 |
| 1748 | " Eclipse Phosphate | .... | 0.18 | 1.75 | 1.93 | 1. | 5.44 | 5.58 | 4.14 | 2.64 | 12.36 | 12. | 9.72 | 10 | 11.33 | 1.49 | 1.5 | 1.34 | 1748 |
| 1967 | " Pat. Superphosphate | 0.29 | 0.13 | 1.96 | 2.38 | 2.05 | 6.66 | 5.68 | 3.71 | 2.29 | 11.68 | 11. | 9.39 | 9 | 10.87 | 2.39 | 2. | 2.15 | 1967 |
| 1749 | " Potato Fertilizer | 0.40 | 0.14 | 1.69 | 2 23 | 2 06 | 6.23 | 5.54 | 3.52 | 2.37 | 11.43 | 11. | 9.06 | 9 | 10.56 | 3.06 | 3.25 | 2.75 | 1749 |
| 1750 | " Potato Manure | 0.67 | 0.16 | 1.85 | 2.68 | 2.5 | 7.47 | 2.71 | 3.46 | 1.91 | 8.08 | 8. | 6.17 | 6 | 7.21 | 5.43 | 5. | 4.89 | 1750 |
| 1751 | " XL Superphosphate | 0 38 | 0.16 | 2.34 | 2.88 | 2.5 | 8.06 | 5.95 | 3.51 | 2.12 | 11.58 | 11. | 9.46 | 9 | 10.90 | 2.08 | 2. | 1.87 | 1751 |
| †1745 | Clark's Cove Bay State G. G. | ... | 0.16 | 2.07 | 2.23 | 1.85 | 6.28 | 4.38 | 4.01 | 2.67 | 11.06 | 11. | 8.39 | 8 5 | 9.90 | 2.19 | 2. | 1.97 | 1745 |
| 1957 | Cleveland Corn & Grain Phos. | 0.46 | .... | 1.71 | 2.17 | 2.06 | 6.03 | 5.03 | 3.75 | 2.93 | 11.71 | 10.5 | 8.78 | 9.5 | 10.46 | 1.62 | 1.5 | 1.46 | 1957 |
| 1752 | " Fertilizer for All Crops | ... | 0.13 | 1.05 | 1.18 | 1.05 | 3.33 | 4.85 | 3.14 | 1.81 | 9.80 | 9. | 7.99 | 8 | 9.20 | 2.28 | 2. | 2.05 | 1752 |

*Potash in brands thus marked is largely, if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprinted from Bulletin 50.

‡Nitrogen, total and available phosphoric acids as given in Bulletin 50 are slightly incorrect.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| †1689 | Cleveland Potato Phosphate | 0.40 | 0.18 | 1.68 | 2.26 | 2.05 | $6.32 | 5.03 | 2.93 | 3.26 | 11.22 | 9. | 7.96 | 8. | $ 9.76 | 3.00 | 3. | $2.70 | 1689 |
| *1972 | Coe's Ammo. Bone Superph'e | --- | 0.28 | 1.77 | 2.00 | 1.75 | 5.65 | 6.61 | 2.20 | 3.85 | 12.66 | 9. | 8.81 | 8. | 11.01 | 1.62 | 1.35 | 1.57 | 1972 |
| *1690 | Coe'sColumbianCorn Ferti'z'r | --- | 0.28 | 1.62 | 1.90 | 1. | 5.38 | 6.59 | 2.05 | 3.05 | 11.69 | 11. | 8.64 | 9. | 10.52 | 2 24 | 1.85 | 2 20 | 1690 |
| *1753 | Coe'sColumbian Potato Fert. | --- | 0.20 | 1.36 | 1.56 | 1. | 4.41 | 6.69 | 2.09 | 3.22 | 12.00 | 11. | 8.78 | 9. | 10.74 | 2.08 | 1.85 | 2.03 | 1753 |
| *1971 | Coe's Grass & Grain Ferti'z'r | --- | --- | 1.23 | 1.23 | 0.8 | 3.44 | 5.74 | 3.88 | 3.80 | 13.42 | 10. | 9.62 | 9. | 11.71 | 1.54 | 1.35 | 1.52 | 1971 |
| 1968 | Crocker's Ammo.BoneSuper. | --- | 0.20 | 2.63 | 2.83 | 2.9 | 7.92 | 8.08 | 2.59 | 0.56 | 11 23 | 11. | 10.67 | 10. | 11.71 | 1.31 | 1. | 1.18 | 1968 |
| 1755 | " Ammo. Corn Phosphate | --- | 0.14 | 2.18 | 2.32 | 2. | 6.52 | 7.14 | 3.46 | 1.37 | 11.97 | 11. | 10.60 | 10. | 11.86 | 2.19 | 1.6 | 1.97 | 1755 |
| 1754 | " NewRivalAmmo.Super | --- | 0.13 | 1.29 | 1.42 | 1.2 | 4 00 | 6.45 | 3.01 | 2.22 | 11 68 | 11. | 9.46 | 10. | 10.99 | 1.91 | 1.6 | 1.72 | 1754 |
| †1691 | " Potato, Hop & Tobacco | --- | 0.11 | 2.03 | 2.14 | 2. | 6.01 | 7.10 | 3.03 | 1.04 | 11.17 | 11. | 10.13 | 10, | 11.26 | 3.56 | 3.25 | 3 20 | 1691 |
| 1978 | " Superior Rye & Oats .. | --- | --- | 1.14 | 1.14 | 0.82 | 3.19 | 6.07 | 1.74 | 3.64 | 11.45 | 9. | 7.81 | 8. | 9.87 | 2.01 | 2. | 1.81 | 1978 |
| 1757 | Cumberland Fertilizer....... | --- | 0.13 | 1.05 | 1.18 | 1.03 | 3.33 | 3.82 | 4.25 | 2.44 | 10.51 | 10. | 8.07 | 8. | 9.43 | 2.34 | 2. | 2.11 | 1757 |
| 1756 | " Potato Fertilizer.. | 0.59 | 0.14 | 1.39 | 2 12 | 2.06 | 5 91 | 5.75 | 3.45 | 2.42 | 11.62 | 11. | 9.20 | 9, | 10.74 | 3.23 | 3. | 2.91 | 1756 |
| †1713 | " Superphosphate .. | 0.12 | 0.15 | 2.00 | 2.28 | 2.06 | 6.40 | 5.58 | 2.49 | 2.65 | 10 67 | 10. | 8.02 | 8. | 9.62 | 2.36 | 2. | 2.12 | 1713 |
| †1746 | Great Easte'n Corn Phosph'te | 0.30 | 0.14 | 2.41 | 2.85 | 3. | 7.98 | 6.63 | 1.97 | 1.40 | 10.00 | 9. | 8.60 | 8. | 9.82 | 2.29 | 2. | 2.06 | 1746 |
| 1973 | " " General Fertilizer | 0.21 | 0.14 | 0.61 | 0.96 | 0.8 | 2.69 | 6.74 | 1.68 | 1.12 | 9 49 | 9. | 8.37 | 8. | 9.49 | 4.31 | 4. | 3.88 | 1973 |
| 1956 | " " Grass & OatsFert. | --- | --- | --- | ---- | ---- | ----- | 7.58 | 3.52 | 1.84 | 12.39 | ---- | 11.05 | 11. | 12.34 | 2.36 | 2. | 2.12 | 1956 |
| 1969 | " " Potato Manure... | 0.32 | --- | 2.01 | 2.33 | 2. | 6 49 | 6.28 | 2.10 | 1.78 | 10.06 | 9. | 8.33 | 8. | 9.65 | 4.30 | 4. | 3.87 | 1969 |

* Potash in brands thus marked is largely, if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† Reprinted from Bulletin 50.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed, | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices | |
| 1974 | **Lister's Anm'l Bone&Potash** | .. . | .. . | .. . | .... | .... | $ ... | 7.76 | 1.86 | 0.68 | 10.30 | 10 | 9.62 | 9 | $10.67 | 5.37 | 5 | $4.83 | 1974 |
| †1714 | Lister's Success Fertilizer... | .. . | 0.21 | 1.37 | 1.58 | 1.23 | 4.47 | 8.25 | 1.23 | 2.80 | 12.28 | 11.5 | 9.48 | 9 | 11 43 | 2.21 | 2 | 1.99 | 1714 |
| †1747 | P.G. Co's Soluble Pacific. Gu. | 0.34 | 0.15 | 1.72 | 2.21 | 2.25 | 6.19 | 5.68 | 3.68 | 2.13 | 11.49 | 10.5 | 9.36 | 8.5 | 10.77 | 2.37 | 2 | 2.13 | 1747 |
| 1958 | P.G.Co's Spec. Potato & Tob. | 0.45 | 0.20 | 1.91 | 2.56 | 2.06 | 7.17 | 5.31 | 3.06 | 2.49 | 10.86 | 9 | 8.37 | 8 | 9.90 | 3.19 | 3 | 2.87 | 1958 |
| 1758 | Quinnipiac Climax Phosph't | .. . | 0.18 | 1.05 | 1.18 | 1.03 | 3.33 | 4.86 | 3.17 | 1.67 | 9.70 | 9 | 8.03 | 8 | 9.18 | 2.16 | 2 | 1.94 | 1758 |
| ‡†1715 | Quinnipiac Corn Manure.... | 0.29 | 0.14 | 1.81 | 2.33 | 2.06 | 6.51 | 4.56 | 4.12 | 2.92 | 11.60 | 10. | 8.68 | 9 | 10.30 | 1.52 | 1.5 | 1.37 | 1715 |
| 1759 | Quinnipiac Potato &Tobacco | 0.54 | 0.13 | 1.57 | 2.24 | 2.05 | 6.24 | 5.23 | 3.51 | 2.91 | 11.65 | 9 | 8.74 | 8 | 10.42 | 3.17 | 3 | 2.85 | 1759 |
| 1976 | Read's Farmers'Friend Super | 0.07 | 0.18 | 1.95 | 2.20 | 2.06 | 6 19 | 7.52 | 2.29 | 1.13 | 10.94 | 10 | 9.81 | 9 | 11.01 | 2.03 | 2 | 1.83 | 1976 |
| 1975 | Read's Fish, Bone & Potash | .. . | 0.18 | 2.57 | 2.75 | 2.47 | 7.74 | 2.85 | 2.46 | 1.78 | 7.09 | 5 | 5.31 | 4 | 6.31 | 4.43 | 4 | 3.99 | 1975 |
| 1960 | Read's Leader Guano....... | 0.18 | .. . | 0.93 | 1.11 | 0.82 | 3.09 | 4.83 | 2.52 | 0.75 | 8.10 | 8 | 7.35 | 7 | 8.13 | 2.48 | 2 | 2.23 | 1960 |
| 1961 | Read's Practical Pot. Special | 0.16 | .. . | 1.07 | 1.23 | 0.82 | 3.43 | 3.13 | 1.39 | 0.61 | 5.13 | 5 | 4.52 | 4 | 5 06 | 8.49 | 8 | 7.64 | 1961 |
| 1962 | Read's Standard Superphos . | 0.12 | 0.13 | 0.95 | 1 20 | 0.82 | 3 37 | 6.15 | 1.69 | 0.95 | 8.79 | 9 | 7.84 | 8 | 8.84 | 4.70 | 4 | 4.23 | 1962 |
| †1737 | Standard Fertilizer......... | 0.41 | 0.15 | 1.62 | 2.18 | 2. | 6.09 | 6.19 | 2.67 | 2.03 | 10.89 | 10 | 8 86 | 8 | 10.29 | 2 33 | 2 | 2.10 | 1737 |
| 1760 | W.&C.Co'sAmer Pot. & Tob. | 0.58 | 0.16 | 1.45 | 2.19 | 2.06 | 6.11 | 5.54 | 3.24 | 2.49 | 11.27 | 9 | 8.78 | 8 | 10.33 | 3.19 | 3 | 2.87 | 1760 |
| †1692 | W.&C. Co's Am.Corn Phos'te | 0.31 | 0.16 | 1.83 | 2.30 | 2.06 | 6.44 | 4.60 | 3.61 | 3.29 | 11.50 | 10 | 8.21 | 9 | 9.99 | 1.59 | 1.5 | 1.43 | 1692 |
| 1761 | **W.&C.Co's Royal Bone Phos.** | .. . | .. . | 1.25 | 1.25 | 1.03 | 3.50 | 4.72 | 3.57 | 1.94 | 10.23 | 8 | 8.29 | 7 | 9.54 | 2.16 | 2 | 1.94 | 1761 |

***Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.**

**†Reprinted from Bulletin 50.**

**‡Error in total, insoluble and available phosphoric acids as published in Bulletin 50.**

## IV. BRANDS NOT REPORTED IN THIS BULLETIN.

Samples of the following brands are in the laboratory and their analyses will be published on completion in Bulletin 52. In no case have more than two samples of each of these brands been found by the Station agents.

### BOWKER FERTILIZER CO., Boston, Mass.

A. Brand.
D. Brand.
Market Garden Fertilizer.
Potato Phosphate.
Potato and Vegetable Manure.
Square Brand Bone and Potash.
Staple Phosphate.
Stockbridge Manure for Seeding Down.
Stockbridge Manure for Strawberries.
Stockbridge Manure for Top Dressing,
Ten Per Cent. Manure.

### BRADLEY FERTILIZER CO., Boston, Mass.

Complete Manure for Corn and Grain.
Complete Manure for Top Dressing Grass and Grain.
English Lawn Dressing.
Seeding Down Fertilizer.
Seeding Down Manure.
Strawberry Manure.

### CLARK'S COVE GUANO CO., Boston, Mass.

King Philip Alkaline Guano.
Potato and Tobacco Fertilizer.

### CLEVELAND DRYER CO., Cleveland, Ohio.

High Grade.
Superphosphate.

### E. FRANK COE CO., New York, N. Y.

Celebrated Special Potato Fertilizer.
Columbian Brand Superphosphate.
Excelsior Potato Fertilizer.
Gold Brand Excelsior Guano.
Ground Bone and Potash.
High Grade Ammoniated Bone Superphosphate.
Red Brand Excelsior Guano.
XXV Superphosphate.

### CROCKER FERTILIZER AND CHEMICAL Co., Buffalo, N. Y.

Special Potato Manure.

### CUMBERLAND BONE PHOSPHATE Co., Portland, Me.

Seeding Down Fertilizer.

### LISTER'S AGRICULTURAL CHEMICAL WORKS, Newark, N. J.

Special Potato Fertilizer.
Special Potato Fertilizer No. 2.

### LOWELL FERTILIZER Co., Lowell, Mass.

Animal Fertilizer.
Bone Fertilizer.
Potato Phosphate.
Vegetable and Vine.

### PACIFIC GUANO Co., Boston, Mass.

High Grade General Fertilizer.
Nobsque Guano.
Special for Potatoes.

### QUINNIPIAC Co., Boston, Mass.

Phosphate.
Pine Island Phosphate.
Potato Manure.
Potato Phosphate.
Seeding Down Fertilizer.

### READ FERTILIZER Co., New York, N. Y.

Corn and Grain Phosphate.
Vegetable and Vine Fertilizer.

### STANDARD FERTILIZER Co., Boston, Mass.

Guano.
Potato and Tobacco Fertilizer.

### HENRY F. TUCKER Co., Boston, Mass.

Imperial Bone Superphosphate for all crops.

### WILLIAMS & CLARK Co., New York, N. Y.

Americus Ammoniated Bone Superphosphate.
Americus Potato Phosphate.

# 1896.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

# BULLETIN No. 52.

MAY, 1896.

## Analyses of Commercial Fertilizers.

I. SUMMARY OF Nos. 50, 51 and 52. (Page 23).
II. ANALYSES OF LICENSED FERTILIZERS. (Pages 24-37).
III. COMPARATIVE VALUES, 1895 and 1896. (Pages 38-39).
IV. ANALYSES OF MISCELLANEOUS FERTILIZERS. (Pages 40-43).

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FREE PRESS ASSOCIATION.
1896.

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Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

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*Connected with Fertilizer Control.

# BULLETIN NO. 52. COMMERCIAL FERTILIZERS.

By J. L. Hills, B. O. White and C. H. Jones.

## I. SUMMARY.

**II. The trade values of fertilizing ingredients in mixed goods this year are 13½, 15 and 14 cents per pound for nitrogen in nitrates, ammonia salts and in organic forms respectively; 5½, 5 and 2 cents per pound for soluble, reverted, and insoluble phosphoric acids; 5 and 4½ cents per pound for potash as sulphate and as muriate. (Bul. 50, pp. 4-5.)**

*These trade values do not represent the proper selling prices of mixed goods at the point of consumption,* **but are the retail cash prices, of the various fertilizing ingredients in the large markets, unmixed but ready for use. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance. (Bul. 50, p. 6.)**

**The Station has analyzed samples of 110 distinct brands of fertilizers, all taken this spring from dealers' stocks and all this years' goods. This is 18 more than were analyzed in 1895 and 57 more than in any year previous to that time.**

**Of 110 brands analyzed, 70 (nearly two-thirds) were above guarantee throughout. Of the 40 deficient brands, 21 were but slightly short in a single ingredient, but three were lacking in two ingredients, and but one was seriously deficient. Practically five-sixths of the brands sold in Vermont this year are equal to or better than guarantees, and 99 per cent. are commercially equivalent to guarantees In no year previous have so good results been obtained. (Pages 24-37.)**

**III. The average composition of 71 brands sold in Vermont in 1895 and 1896 shows a slightly better quality this year and an increase of forty cents in valuation. Prices are a little less, but have not dropped in proportion to the lessened cost of crude stock. The increase of cost over valuation of the average goods is 57 per cent., the highest since the Station begun to execute the State law ten years ago. Yet plant food is as cheap to-day to the farmer as it has ever been. If former prices were fair, however, it should be cheaper now than ever before. (Pages 38-39.)**

**IV. The analyses of 13 samples of ashes and 9 samples of muck show the usual wide variation in the quality of these products, and again emphasize the wisdom of submitting them to Station analysis. (Pages 40-43.)**

## II. ANALYSES OF LICENSED FERTILIZERS.

Seventeen firms are licensed to sell commercial fertilizers in Vermont in 1896, M. E. Wheeler & Co. of Rutland, Vt. having taken out license since the list was published in Bulletin 50. The address of each company may be found under the heading of "licensed fertilizers sampled by Station" in this bulletin.

One hundred and ten distinct brands manufactured by these firms have been sampled and analyzed and are grouped alphabetically in this issue. Bulletins 50 and 51 issued during the progress of the analytical work have contained analyses of the brands more commonly used. It is believed that every brand sold in the State this spring with two exceptions has been sampled and analyzed.

Of the 110 brands analyzed, 70 or nearly *two-thirds* were found to be above guarantee in nitrogen, available phosphoric acid and potash. Of the 40 brands found deficient, 21 were short less than 0.20 per cent. in a single ingredient, so that *practically five-sixths of the brands sold this year in Vermont were found to be essentially equal to or better than their guarantees.* But 3 brands in 110 proved deficient in two ingredients, and none was lacking in all three.

In two of these three the shortage was less than 0.10 per cent. in one of the two deficient ingredients and a sufficient excess of the third ingredient was present to give the commercial equivalent of the guarantee. This is also the case with each of the 16 brands over 0.20 per cent. deficient in a single ingredient. The single case of serious deficiency is in a brand which apparently has had thus far but a limited sale in the State.

This result is much more satisfactory than has been obtained hitherto. In no year previous has it been possible to report that practically *all* the brands sold in the State made good their guarantees. It is to be hoped that equally good results may be obtained in succeeding years.

### HOW TO CALCULATE A STATION VALUATION.

The schedule of trade values used in this State in 1896, is the one agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut and New Jersey, after a careful study of prices ruling in the large markets of the New England and Middle States. It was printed in Bulletin 50 with an explanation of its application to superphosphates and mixed goods. So far as these values apply to mixed goods they are:

Nitrogen in nitrates, 13½ cts. per pound.
Nitrogen in ammonia salts, 15 cts. per pound.
Organic nitrogen, 14 cts. per pound.
Phosphoric acid soluble in water, 5½ cts per pound.
Phosphoric acid soluble in ammonium citrate, 5 cts. per pound.
Phosphoric acid insoluble in mixed fertilizers, 2 cts. per pound.

Potash as high grade sulphate or free from muriate or chlorid, 5 cts. per pound.

Potash as muriate, 4½ cts. per pound.

In order that there may be no misconception and that the reader may clearly appreciate what these valuations are and what they are not, it is our custom to repeatedly call attention to the fact that **the Station valuation of a brand of fertilizer does not represent the proper selling price at the point of consumption,** but shows the retail cash prices of the various fertilizing ingredients in the large markets, unmixed but ready for use. It does not include freight, cost of manufacture, storage, commissions, etc. It stands in no necessary relation to the profits derived from the use of the goods, but has an almost purely commercial significance. For further information regarding trade values see Bulletin 50.

The "Station valuation" of a fertilizer may be obtained by *multiplying the given per cent. of each constituent (nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.* In calculating valuations from guarantees it should be noted that the lower figure is all the seller is bound to deliver. For instance, 2 to 4 per cent. potash guarantees 2 per cent. only.

To reduce ammonia to nitrogen, multiply per cent. given by .82; to reduce sulphate of potash to potash, multiply per cent. given by .54.

### EXPLANATION OF TERMS USED IN FERTILIZER GUARANTEES AND ANALYSES.

The State law requires that fertilizers sold in Vermont "shall be accompanied by a chemical analysis stating percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form, soluble in distilled water and reverted as well as the total phosphoric acid." Some of the manufacturers comply in the matter of guarantees with both the letter and the spirit of the law, while many comply with the spirit only. All sorts of guarantees are found. Nitrogen is expressed as (1) nitrogen, (2) nitrogen equal to ammonia or nitrogen equivalent to ammonia or (3) ammonia. The phosphoric acids are expressed as (1) soluble, (2) soluble and available, (3) available, (4) sometimes as total only and often also as (5) bone phosphate of lime. Potash is expressed as (1) potash, (2) potash as sulphate, (3) potash equal to sulphate or potash equivalent to sulphate, (4) potash-sulphate or sulphate of potash. In general it may be said that terms other than those required by law are used principally to make a show of giving larger amounts of plant food than are actually present. For instance a common guarantee is "Nitrogen equivalent to Ammonia, 2.5 per cent." This is not a guarantee of 2.5 per cent. of nitrogen but of sufficient nitrogen to form 2.5 per cent. ammonia or 2.06 per cent. nitrogen (since but 82.3 per cent. of ammonia is nitrogen). The large amounts of bone phosphate of lime frequently seen in guarantees add nothing to the value of the goods, being but the calculation of the total phosphoric acid into its combined form of tri-calcic phosphate. The terms potash-sulphate, potash as sulphate, potash equal to or equivalent to sulphate, sometimes mean one thing (potash) and some times another (potassium sulphate of which but 54 per cent. is actual potash).

In this connection attention should be called to the very general claim made directly or inferentially (*i. e.* by using some such terms as "equal to" or "equivalent to sulphate of potash") that sulphate of potash is used in the goods sold. It is instructive to compare claims and facts in this matter. Of the 110 brands reported in this bulletin, 97 claim, directly or by inference, to contain potash in the form of sulphate. Analysis confirms the claim in 19 brands, while in 78 brands, or four-fifths of those for which the claim is made, the potash is present either in the cheaper, and, for some purposes, somewhat less desirable form of muriate, or else sufficient chlorin is present in other ingredients to overcome any beneficial effects of the sulphate. Brands actually containing most if not all potash as sulphate are marked * in the tables.

The figures in the tables of analyses of licensed fertilizers show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under specified conditions, and soluble in plant and root acids; 9, of phosphoric acid insoluble in water or ammonium citrate, and but slowly avilable for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail money value at the seaboard of the unmixed nitrogen, phosphoric acid and potash found in the fertilizer, the same being based on a careful study of the prices of the better forms of crude stock ruling in the leading markets.

## SELLING PRICES AND STATION VALUATIONS.

The office of the Experiment Station under the State law regarding fertilizers is simply to find whether the compositions of the various mixed goods sold correspond with their guarantees, or in other words, whether the guarantee statement is a safe guide in purchase. "Station valuations" alone, while giving little information regarding agricultural values, furnish a common basis on which to compare different brands, and enable buyers to note whether prices asked are warranted by values contained.

The comparison of Station valuations and selling prices of the brands analysed this year is instructive. Grouping 106* of these by selling prices we get the following table:

| Selling Price. | Number of Brands in group. | Cents worth of plant food at retail seaboard prices bought for a dollar at consumer's depot. | | | Number of Brands in group which furnish for a dollar | |
|---|---|---|---|---|---|---|
| | | Highest. | Lowest. | Average. | Less than 60 cents worth plant food. | More than 70 cents worth plant food. |
| $27.99 and below. | 16 | 74 | 52 | 59.5 | 11 | 1 |
| $28.00—$29.99 | 22 | 80 | 48 | 61.3 | 9 | 1 |
| $30.00—$31.99 | 26 | 79 | 51 | 63.9 | 5 | 4 |
| $32.00—$34.99 | 13 | 80 | 57 | 64.0 | 1 | 2 |
| $35.00 and above. | 19 | 81 | 52 | 68.7 | 3 | 8 |

A dollar spent for the average low priced brands (below $30) bought 60.4 cents worth of plant food at retail sea-board prices; a dollar spent for average medium priced goods ($30 to $35), 64 cents worth; and a dollar spent for average high grade goods (above $35), 68.7 cents worth. The very evident reason for this is that the cost of mixing, bagging, freighting and selling low grade material or make-weight is as great as when higher grades are handled.

There is a large demand for low grade goods, which are, as seen by the table, usually the highest priced in proportion to plant food contained. General and local fertilizer agents report difficulty in selling the higher grade, yet really cheaper goods, since buyers seek more for quantity and low price than for quality.

High grade goods in general are more likely to be satisfactory than lower grade, because of the:

1. Larger proportion of the selling price returned in plant food.
2. Greater likelihood that first-class materials are used in manufacture.

Another example taken from the tables in this bulletin, may serve to make still plainer the necessity of carefully studying the relation between guarantees and selling prices. One manufacturer offered this spring in Vermont a brand containing 0.75 per cent. nitrogen, 8 per cent. available phosphoric acid, and 1 per cent. potash. Its average selling price at several points was $27.80. For $2.20 more the same manufacturer offered a brand containing three times as much nitrogen and potash and the same amount of phosphoric acid. In the first brand 58 cents worth of fertility at sea-board prices were bought for a dollar; in the second, 80 cents worth. Yet more striking results may be obtained by comparing the products of rival manufacturers, extremes being 48 cents and 81 cents worth bought for a dollar.

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* Prices not obtained on four brands.

It is very doubtful whether at present prices for farm produce, many farmers can afford to pay from 40 to 52 cents out of every dollar invested in fertilizers to the manufacturer, laborer, railroad and dealer. Yet on the other hand, by careful choice, or, under some circumstances, by the practice of home mixing the use of commercial fertilizers even at present crop prices may prove profitable, particularly if supplemented by proper feeding of farm stock and care for the manure.

## LICENSED FERTILIZERS SAMPLED BY STATION.*

### Bowker Fertilizer Co., Boston, Mass.

1858. **Market Garden Fertilizer**; from stock of A. E. Fuller, Woodstock.

1792. **Potash Phosphate**; from stock of Rumsey and St. John, Castleton.

1981. **Potato and Vegetable Manure**; from stocks of Geo. A. Wales, South Barre; L. F. Fortney, Plainfield.

1865. **Square Brand Bone and Potash**; from stock of H. B. Martin, Bradford.

1982. **Staple Phosphate**; from stocks of Edwards & Grout, Newfane; W. S. Holland, Townsend.

1984. **Stockbridge Manure for Seeding Down**; from stocks of C. G. & H. T. Leach, Pawlet; Edwards & Grout, Newfane.

1801. **Stockbridge Manure for Strawberries**; from stock of H. B. Martin, Bradford.

1983. **Stockbridge Manure for Top Dressing**; from stocks of Geo. A. Wales, South Barre; H. B. Martin, Bradford.

1852. **Ten Per Cent Manure**; from stock of W. P. Champion, Hartford.

1980. **Vermont Grange Chemicals, A Brand**; from stocks of W. H. Champion, Hartford; A. E. Fuller, Woodstock.

1970. **Vermont Grange Chemicals, D Brand**; from stocks of W. H. Champion, Hartford; A. E. Fuller, Woodstock.

### Bradley Fertilizer Co., Boston, Mass.

2000. **B. D. Sea Fowl Guano**; from stock of Ira W. Thorp, Underhill.

1806. **Complete Manure for Corn and Grain**; from stock of Clark & Chamberlain, Bradford.

1734. **Complete Manure for Top Dressing Grass and Grain**; from stock of L. D. Nute, Marshfield.

1892. **English Lawn Dressing**; from stock of A. G. Peirce, Burlington.

1663. **Seeding Down Fertilizer**; from stock of H. W. Gray, Cambridge.

1867. **Seeding Down Manure**; from stock of Clark and Chamberlain, Bradford.

1868. **Strawberry Manure**; from stock of Clark and Chamberlain, Bradford.

2018. **Vermonter**; from stocks of Ira W. Thorp, Underhill; Geo. H. Kay, Walden.

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*The names and locations of agents from whom samples were taken which made analytical samples reported in Bulletins 50 and 51, and reprinted in this Bulletin, may be found on reference thereto.

### Clark's Cove Fertilizer Co., Boston, Mass.

**1985. King Philip Guano**; from stocks of A. A. Olmstead, South Newbury; W. B. D. Avery, Bradford.

**1986. Potato and Tobacco Manure**; from stocks of A. A. Olmstead, South Newbury; W. B. D. Avery, Bradford.

### Cleveland Dryer Co., Cleveland, O.

**2017. High Grade Complete Manure for all Crops**; from stock of S. C. Wheeler, Waterbury.

**2016. High Grade Complete Manure for all Crops**; from stock of M. A. Nelson, Montpelier.

**1994. Superphosphate**; from stocks of R. D. Stewart, Berlin; D. A. Spooner, Randolph.

### E. Frank Coe Co., New York, N. Y.

**1988. Celebrated Special Potato Fertilizer**; from stocks of Martin Lee, Castleton; Lorimer & Macdairand, Newport.

**1733. Columbian Brand Ammoniated Bone Superphosphate**; from stock of Silsby and Knight, Newbury.

**1934. Excelsior Potato Fertilizer**; from stock of L. F. Shorey & Son, Lyndonville.

**1989. Gold Brand Excelsior Guano**; from stocks of Silas Giddings, Castleton; Geo. H. Dunn, Pownal.

**1931. Ground Bone and Potash**; from stock of L. F. Shorey & Son, Lyndonville.

**1987. High Grade Ammoniated Bone Superphosphate**; from stocks of A. Bemis, Marshfield; Lorimer & Macdairand, Newport.

**1788. Red Brand Excelsior Guano**; from stock of Silas Giddings, Castleton.

**1905. XXV Superphosphate**; from stock of Owen McGinn, Fairfield.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**2016. Ammoniated Bone Superphosphate**; from stocks of A. B. & G. I. H. Smith, Morrisville; C. H. Bliss, Hyde Park.

**1912. Special Potato Manure**; from stock of G. W. Gillis, Danville.

**2020. Special Potato Manure**; from stock of W. J. Clapp, Barre.

### Cumberland Bone Phosphate Co., Portland, Me.

**1829. Seeding Down Manure**; from stock of Valley Grain Co., Brattleboro.

### Lister's Agricultural Chemical Works, Newark, N. J.

**1999. Potato Manure No. 1**; from stock of M. V. Leach, Essex.

**1859. Potato Fertilizer No. 2**; from stock of Isaiah Benson, West Woodstock.

**1990. Special Potato Fertilizer**; from stocks of T. J. Gagner, St. Johnsbury; F. B. Harlow, Hartland.

### Lowell Fertilizer Co., Lowell, Mass.

**2011. Animal Fertilizer**; from stock of A. Barron, White River Junction.

**2012. Bone Fertilizer**; from stocks of A. Barron, White River Junction; G. B. Arnold, Burlington.

**2013. Potato Phosphate**; from stocks of A. Barron, White River Junction; G. B. Arnold, Burlington.

**2014. Vegetable and Vine Fertilizer**; from stocks of A. Barron. White River Junction; G. B. Arnold, Burlington.

### Pacific Guano Co., Boston, Mass.

**1894. High Grade General Fertilizer**; from stock of Jones & Isham, Burlington.

**1991. Nobsque Guano**; from stocks of E. H. Wakeman, North Troy: E. Walbridge, North Bennington.

**1824. Special for Potato and Tobacco**; from stock of L. T. & W. H. Landman, Londonderry.

### Quinnipiac Co., Boston, Mass.

**1993. Phosphate**; from stocks of Mellin & Proctor, Brattleboro; W. R. Sturtevant, Hartland.

**1909. Pine Island Phosphate**; from stock of E. E. Harris, Morrisville.

**1992. Potato Manure**; from stocks of Mellin & Proctor, Brattleboro; W. R. Sturtevant, Hartland.

**1722. Potato Phosphate**; from stock of F. W. Pierce, Fairlee.

**1795. Seeding Down Manure**; from stock of H. Ballard, Poultney.

### Read Fertilizer Co., New York, N. Y.

**2011. Chicopee Corn and Wheat Mixture**; from stock of S. P. Gordon, Pearl.

**1998. Vegetable and Vine Fertilizer**; from stock of Gove, Nott & Taylor, Burlington.

### Standard Fertilizer Co., Boston, Mass.

**1735. Guano**; from stock of C. W. Atherton, Waterbury.

**1736. Potato and Tobacco Fertilizer**; from stock of C. W. Atherton, Waterbury.

**2021. Potato and Tobacco Fertilizer**; from stock of L. H. Lamphier, Elmore.

### Henry F. Tucker Co., Boston, Mass.

**1895. Imperial Bone Superphosphate for All Crops**; from stock of F. B. Gillette, Jonesville.

**2002. Special Potato Fertilizer**; from stock of H. H. Scott, Bakersfield.

### M. E. Wheeler & Co., Rutland, Vt.

**2006. Corn Fertilizer**; from stock of C. U. Lathrop, Williamstown.

**2007. Grass and Oats Fertilizer**; from stock of C. U. Lathrop. Williamstown.

**2008. Potato Manure**; from stock of C. U. Lathrop, Williamstown.

**2009. Royal Wheat Grower**; from stock of C. U. Lathrop, Williamstown.

**2010. Superior Truck**; from stock of C. U. Lathrop, Williamstown.

### Williams & Clark Co., New York, N. Y.

**1827. Ammoniated Bone Superphosphate**; from stock of O. L. Miner. Brattleboro.

**1826. Potato Phosphate**; from stock of O. L. Miner, Brattleboro.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| †1744 | Bowker's Corn Phosphate... | 0.58 | - - - | 1.35 | 1.93 | 1.5 | $5.35 | 5.35 | 3.42 | 2.80 | 11.57 | 11. | 8.77 | 9. | $10.43 | 2.41 | 2. | $2.17 | 1744 |
| ‡1970 | " Farm & Garden Phos. | 0.48 | - - - | 1.39 | 1.87 | 1.6 | 5.19 | 5.09 | 3.40 | 2.75 | 11.24 | 10. | 8.49 | 8. | 10.10 | 2.37 | 2. | 2.13 | 1970 |
| ‡1963 | " Hill & Drill Phos.... | 0.77 | 0.13 | 1.61 | 2.51 | 2.5 | 6.98 | 8.12 | 2.37 | 1.74 | 12.23 | 12. | 10.49 | 9. | 12.00 | 2.46 | 2. | 2.21 | 1968 |
| 1858 | " Market Garden Fert . | 1.22 | - - - | 1.50 | 2.72 | 2.47 | 7.49 | 6.24 | 2.44 | 3.66 | 12.34 | 8. | 8 68 | 6. | 10.77 | 10.70 | 10. | 9.63 | 1858 |
| 1792 | " Potash Phosphate. .. | 0.31 | - - - | 0.76 | 1.07 | 0.82 | 2.97 | 4.95 | 4.64 | 1.87 | 11.46 | 9. | 9.59 | 7. | 10.83 | 4.81 | 5. | 4.33 | 1792 |
| 1981 | " Potato and Vegetable | 0.78 | 0.13 | 1.67 | 2.58 | 2.05 | 7.17 | 7.56 | 3.10 | 2.00 | 12.66 | 10. | 10.66 | 8. | 12.22 | 4.89 | 4. | 4.40 | 1981 |
| ‡1966 | " Potato Phosphate.... | 0.46 | - - - | 1.30 | 1.76 | 1.5 | 4 88 | 4 96 | 3.81 | 3.14 | 11.91 | 10. | 8.77 | 8. | 10.52 | 2.45 | 2. | 2.20 | 1966 |
| 1865 | " Sqr.Br.Bone & Potash | 0.37 | - - - | 1.56 | 1.93 | 1.5 | 5.37 | 3.30 | 5.82 | 6.17 | 15.29 | 12. | 9.12 | - | 11.92 | 2.31 | 2. | 2.08 | 1865 |
| 1982 | " Staple Phosphate.... | 0.30 | - - - | 0.90 | 1 20 | 0.82 | 3.33 | 5.49 | 4.28 | 2.53 | 12.30 | 10. | 9.77 | 8. | 11.33 | 3.67 | 3. | 3.30 | 1982 |
| ‡1977 | " Stockb'ge Corn Manure | 1.26 | - - - | 2.36 | 3.62 | 3.25 | 10.01 | 7.88 | 2.11 | 1.90 | 11.89 | 10. | 9.99 | 8. | 11.54 | 4.51 | 4. | 4.06 | 1977 |
| ‡1959 | " " Potato " | 1.26 | 0.14 | 1.77 | 3.17 | 3.25 | 8.78 | 3.29 | 2.39 | 2.85 | 8.53 | 8. | 5.68 | 5. | 7.15 | 9.71 | 10. | 8.74 | 1959 |
| 1984 | " " Seedng D'n" | 1.13 | - - - | 1.45 | 2.58 | 2.5 | 7.11 | 5.44 | 3.26 | 4.43 | 13.13 | 12. | 8.70 | 6. | 11.02 | 9.88 | 10. | 8.89 | 1984 |
| *1861 | " " Strawb'ry " | 0.76 | - - - | 1.84 | 2.60 | 2.5 | 6.36 | 7.44 | 2.82 | 2.12 | 12.38 | 7. | 10.26 | 6. | 11.85 | 3.72 | 4. | 3.69 | 1861 |
| 1983 | " " Top Dr's'g " | 2.56 | 0.13 | 2.42 | 5.11 | 5. | 14.08 | 3.51 | 2.80 | 2.51 | 8.82 | 6. | 6.31 | 4. | 7.67 | 6.61 | 6. | 5.95 | 1983 |
| ‡1965 | " Sure Crop Phosphate. | 0.31 | - - - | 0.83 | 1.14 | 0.75 | 3.16 | 6.09 | 3.88 | 2.76 | 12.73 | 10. | 9.97 | 8. | 11.68 | 1.28 | 1. | 1.15 | 1965 |
| 1852 | " Ten Per Cent Manure | 0.30 | - - - | 0.70 | 1.00 | 0.82 | 2.77 | 1.98 | 4.22 | 2.91 | 9.11 | 8. | 6.20 | 5. | 7.56 | 10.18 | 10. | 9.16 | 1852 |

* Potash in brands thus marked is largely, if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprinted from Bulletin 50. ‡Reprinted from Bulletin 51.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| 1980 | Bowker's Vt. Gng. Chem. A B'd | 0.58 | 0.13 | 1.31 | 1.97 | 1.25 | $5.49 | 5.89 | 3.93 | 2.66 | 11.98 | 9. | 9.32 | 8. | $10.92 | 2.90 | 2. | $2.61 | 1980 |
| 1979 | “ “ “ D “ | 0.55 | 0.20 | 1.67 | 2.42 | 2.06 | 6.76 | 7.97 | 2.80 | 1.20 | 11.97 | 9. | 10.77 | 8. | 12.05 | 4.45 | 3. | 4.00 | 1979 |
| ‡1964 | “ Vermont Phosphate | 0.50 | 0.27 | 1.77 | 2.54 | 2.06 | 7.12 | 8.20 | 2.62 | 1.42 | 12.24 | 10. | 10.82 | 8. | 12.21 | 4.71 | 3. | 4.24 | 1964 |
| 2000 | Bradley's B. D. Sea Fowl Guano | 0.40 | 0.13 | 1.73 | 2.26 | 2.06 | 6.31 | 4.79 | 5.52 | 2.13 | 12.44 | 10. | 10.31 | 8. | 11.64 | 1.45 | 1.5 | 1.31 | 2000 |
| 1866 | “ Complete Corn&Grain | 1.18 | - - - | 2.07 | 3.25 | 3.3 | 8.98 | 3.95 | 5.77 | 2.88 | 12.10 | 13. | 9.72 | 12. | 11.07 | 6.63 | 3. | 5.97 | 1866 |
| *1784 | “ “ Top Dressing | 8.64 | - - - | 1.49 | 5.13 | 4.95 | 14.00 | 2.54 | 2.62 | 1.24 | 6.40 | 6. | 5.16 | 5. | 5.91 | 2.89 | 2.5 | 2.77 | 1784 |
| †1688 | “ Corn Phosphate | 0.57 | - - - | 1.76 | 2.33 | 2. | 6.47 | 4.96 | 3.95 | 2.90 | 11.81 | 10. | 8.91 | 9. | 10.58 | 1.72 | 1.5 | 1.55 | 1688 |
| ‡1748 | “ Eclipse Phosphate | - - - | 0.18 | 1.75 | 1.93 | 1. | 5.44 | 5.58 | 4.08 | 2.71 | 12.37 | 12. | 9.66 | 10. | 11.30 | 1.49 | 1.5 | 1.34 | 1748 |
| *1892 | “ English Lawn Dressing | 8.44 | - - - | 1.61 | 5.05 | 4.95 | 13.80 | 2.37 | 8.83 | 1.16 | 6.86 | 6. | 5.70 | 5. | 6.40 | 2.88 | 2.5 | 2.77 | 1892 |
| ‡1967 | “ Pat. Superphosphate | 0.29 | 0.18 | 1.96 | 2.38 | 2.05 | 6.66 | 5.68 | 3.71 | 2.29 | 11.68 | 11. | 9.39 | 9. | 10.87 | 2 39 | 2. | 2.15 | 1967 |
| ‡1749 | “ Potato Fertilizer | 0.40 | 0.14 | 1.69 | 2.23 | 2.06 | 6.23 | 5.54 | 8.52 | 2.37 | 11.43 | 11. | 9 06 | 9. | 10.56 | 3.06 | 3.25 | 2.75 | 1749 |
| ‡1750 | “ Potato Manure | 0.67 | 0.16 | 1.85 | 2.68 | 2.5 | 7.47 | 2.71 | 3.46 | 1.91 | 8.08 | 8. | 6.17 | 6. | 7.21 | 5.43 | 5. | 4.89 | 1750 |
| 1668 | “ Seeding Down Fert'er | 0.41 | 0.16 | 1.55 | 2 12 | 1.35 | 5.93 | 6.99 | 2.03 | 2.36 | 11.38 | 10. | 9.02 | 5. | 10.66 | 2.03 | 1.08 | 1.83 | 1668 |
| 1867 | “ Seeding Down Man're | 0.51 | 0.18 | 2.81 | 2.95 | 2.5 | 8.24 | 6.21 | 4.40 | 1.78 | 12.39 | 12. | 10.61 | 7. | 11.94 | 2.26 | 2. | 2.03 | 1867 |
| 1868 | “ Strawberry Manure | 0.67 | 0.28 | 1.72 | 2.62 | 2.5 | 7.31 | 2.88 | 8.97 | 1.86 | 8.71 | 8. | 6 85 | 6. | 7.88 | 5.16 | 5. | 4.64 | 1868 |
| 2018 | “ Vermonter | 0.37 | 0.18 | 1.78 | 2.28 | 2.06 | 6.38 | 4.46 | 4.87 | 1.95 | 11.28 | 10. | 9.33 | 8. | 10.56 | 3.09 | 3.5 | 2.78 | 2018 |

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*Potash in brands thus marked is partly, if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprinted from Bulletin 50. ‡Reprinted from Bulletin 51.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| ‡1751 | Bradley's XLSuperphosphate | 0.38 | 0.16 | 2.34 | 2.88 | 2.5 | $8.06 | 5.95 | 3.51 | 2.12 | 11.58 | 11. | 9.46 | 9. | $10.90 | 2.08 | 2. | $1.87 | 1751 |
| †1745 | Clark's Cove Bay State G. G. | - - - | 0.16 | 2.07 | 2.23 | 1.85 | 6.28 | 4.36 | 4.08 | 2.67 | 11.06 | 11. | 8.39 | 8.5 | 9.90 | 2.19 | 2. | 1.97 | 1745 |
| 1985 | " King Philip Guano | - - - | 0 13 | 1.12 | 1.25 | 1.03 | 3.53 | 4.60 | 3.64 | 2.14 | 10.38 | 9. | 8.24 | 8. | 9.56 | 2.54 | 2. | 2.29 | 1985 |
| 1986 | " Potato and Tobacco | 0.38 | 0.16 | 1.60 | 2.14 | 2.06 | 5.99 | 4.82 | 4.32 | 2.48 | 11.62 | 9. | 9.14 | 8. | 10.61 | 3.31 | 3. | 2.98 | 1986 |
| ‡1957 | Cleveland Corn & Grain Phos. | 0.46 | - - - | 1.71 | 2.17 | 2.06 | 6.03 | 5.03 | 3.77 | 2.93 | 11.73 | 10.5 | 8.80 | 9.5 | 10.48 | 1.62 | 1.5 | 1.46 | 1957 |
| †1752 | " Fertilizer for all Crops | - - - | 0.13 | 1.05 | 1.18 | 1.05 | 3.33 | 4.85 | 3.14 | 1.81 | 9.80 | 9. | 7.99 | 8. | 9.20 | 2.28 | 2. | 2.05 | 1752 |
| 2017 | " High Grade Complete | 1.40 | - - - | 1.91 | 3.31 | 3.29 | 9.13 | 4.53 | 4.08 | 1.48 | 10.09 | 9. | 8.61 | 8. | 9.66 | 6 23 | 7. | 5.61 | 2017 |
| §2015 | " " " " | 1.39 | - - - | 2.00 | 3.39 | 3.29 | 9.35 | 4.09 | 4.44 | 2.12 | 10.65 | 9. | 8.53 | 8. | 9.79 | 6.95 | 7. | 6.26 | 2015 |
| †1689 | " Potato Phosphate | 0.40 | 0.18 | 1.68 | 2.26 | 2.05 | 6.32 | 5.03 | 2.88 | 3.31 | 11.22 | 9. | 7.91 | 8. | 9.73 | 3.00 | 3. | 2.70 | 1689 |
| 1994 | " Superphosphate | 0.28 | 1.16 | 1.66 | 2.10 | 2.05 | 5.89 | 6.20 | 2.86 | 2.10 | 11.16 | 11. | 9.06 | 9. | 10.52 | 2.41 | 2. | 2.17 | 1994 |
| *‡1972 | Coe's Ammo. Bone Superph'e | - - - | 0.23 | 1.77 | 2.00 | 1.75 | 5.65 | 6.61 | 2.20 | 3.85 | 12.66 | 9. | 8.81 | 8. | 11.01 | 1.62 | 1.35 | 1.57 | 1972 |
| *1988 | " Celebr. Special Potato | - - - | 0.18 | 1.59 | 1.77 | 1.65 | 4.99 | 6.25 | 3.46 | 3.21 | 12.92 | 11. | 9.71 | 9. | 11.62 | 3.74 | 3.5 | 3.72 | 1988 |
| *1733 | " Columbian Br. Am. Bone | - - - | 0.18 | 1.38 | 1.56 | 1.2 | 4.40 | 5.56 | 3.97 | 3.76 | 13.29 | 11. | 9.53 | 9. | 11.59 | 2.29 | 1.85 | 2.24 | 1733 |
| *†1690 | " " Corn Fertilizer | - - - | 0.26 | 1.64 | 1.90 | 1. | 5.38 | 6.59 | 2.08 | 3.05 | 11.72 | 11. | 8.67 | 9. | 10.55 | 2.24 | 1.85 | 2.20 | 1690 |
| *‡1758 | " " Potato Fertilizer | - - - | 0.20 | 1.36 | 1.56 | 1. | 4.41 | 6.69 | 2.10 | 3.22 | 12.01 | 11. | 8.79 | 9. | 10.75 | 2.08 | 1.85 | 2.03 | 1758 |
| *1934 | " Excelsior Potato Fert. | - - - | 0.76 | 2.13 | 2.89 | 2.5 | 8.24 | 7.29 | 1 24 | 0.97 | 9.50 | 8. | 8.53 | 8. | 9.65 | 7.65 | 8. | 7.61 | 1934 |
| *1989 | " Gold Br. Exc'or Guano | - - - | 0.86 | 1.84 | 2.70 | 2.5 | 7.73 | 6.88 | 1.61 | 1.00 | 9.49 | 9. | 8.49 | 8. | 9.58 | 6.25 | 6. | 6.19 | 1989 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprinted from Bulletin 50. ‡Reprinted from Bulletin 51.

§Two samples of this brand were analyzed, doubt having arisen regarding correctness of Waterbury sample.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| *‡1971 | Coe's Grass & Grain Ferti'z'r | ... | ... | 1.23 | 1.23 | 0 8 | $3.44 | 5.74 | 3.88 | 3.80 | 13.42 | 10. | 9.62 | 9 | $11.71 | 1.54 | 1 35 | $1.52 | 1971 |
| 1931 | " Ground Bone & Potash | ... | ... | 2.02 | 2.02 | 2. | 5.66 | 0.04 | 8.42 | 7.12 | 15.58 | 12.8 | 8.46 | .... | 11.71 | 2.69 | 2.5 | 2.42 | 1931 |
| *1987 | " HighGrade A.B. Super. | ... | 0.40 | 1.85 | 2.25 | 2. | 6 38 | 7.00 | 2.33 | 2.42 | 11.75 | 11. | 9 33 | 9. | 11 00 | 2.15 | 1 85 | 2.07 | 1987 |
| *1788 | " Red Br.ExcelsiorGuano | ... | 0.85 | 2.41 | 3.26 | 3. | 9.16 | 6.37 | 1.85 | 2.09 | 10.31 | 10. | 8.22 | 8. | 9.69 | 5.95 | 6. | 5.90 | 1788 |
| *1905 | " XXV Superphosphate | ... | ... | 1.14 | 1 14 | 1. | 3.19 | 3.35 | 5.54 | 4.81 | 13.70 | 9. | 8 89 | 8. | 11.15 | 1 09 | 1. | 1.05 | 1905 |
| ‡1968 | Crocker's Ammo.BoneSuper. | ... | 0.20 | 2.63 | 2 83 | 2.9 | 7.96 | 8.07 | 2.60 | 0.56 | 11.23 | 11. | 10 67 | 10. | 11.71 | 1.31 | 1. | 1.18 | 1968 |
| §2016 | " " " " | ... | 0.18 | 2.57 | 2.75 | 2.9 | 7.74 | 7.91 | 2.58 | 0.49 | 10.98 | 11. | 10.49 | 10. | 11.49 | 1.47 | 1. | 1.32 | 2016 |
| ‡1755 | " Ammo. Corn Phosphate | ... | 0.14 | 2.18 | 2.32 | 2. | 6 52 | 7.14 | 3.46 | 1.87 | 11.97 | 11. | 10 60 | 10. | 11 86 | 2.19 | 1.6 | 1.97 | 1755 |
| ‡1754 | " NewRivalAmmo.Super | ... | 0.13 | 1.29 | 1.42 | 1.2 | 4 00 | 6.45 | 3.06 | 2.22 | 11.73 | 11. | 9.51 | 10. | 11.04 | 1 91 | 1.6 | 1.72 | 1754 |
| †1691 | " Potato, Hop & Tobacco | ... | 0.11 | 2.03 | 2 14 | 2 | 6 01 | 7.10 | 3.03 | 1.04 | 11.17 | 11. | 10.13 | 10. | 11.26 | 3 56 | 3 25 | 3 20 | 1691 |
| 1912 | " Special Potato Manure. | ... | ... | 3.75 | 3.75 | 3 7 | 10 50 | 5.27 | 3.10 | 1.47 | 9 84 | 9. | 8 37 | 8. | 9.47 | 5.23 | 5.4 | 4.71 | 1912 |
| 2020 | " " " " | ... | .. | 3.98 | 3.98 | 3.7 | 11.14 | 5.47 | 2.81 | 1.58 | 9.56 | 9. | 7.98 | 8. | 8.96 | 6.26 | 5.4 | 5 63 | 2020 |
| ‡1978 | " Superior Rye & Oats | ... | ... | 1.14 | 1 14 | 0.82 | 3.19 | 6 07 | 1.75 | 3.64 | 11.46 | 9. | 7 82 | 8. | 9 88 | 2 01 | 2. | 1 81 | 1978 |
| ‡1757 | Cumberland Fertilizer | ... | 0.18 | 1.06 | 1.18 | 1 03 | 3.33 | 3.82 | 4.25 | 2.44 | 10.51 | 10. | 8.07 | 8. | 9.43 | 2 34 | 2. | 2.11 | 1757 |
| ‡1756 | " Potato Fertilizer | 0.58 | 0.14 | 1.39 | 2.12 | 2.06 | 5.91 | 5.75 | 3.45 | 2.42 | 11.62 | 11. | 9.20 | 9. | 10.74 | 3.23 | 3. | 2 91 | 1756 |
| 1829 | " SeedingDownM'n'e | ... | ... | 1.28 | 1 28 | 0.82 | 3 58 | 3.52 | 4.91 | 2.11 | 10.54 | 8. | 8 43 | 7. | 9.63 | 2.45 | 1. | 2 20 | 1829 |
| †1718 | " Superphosphate | 0.14 | 0.16 | 1.98 | 2.28 | 2 06 | 6.40 | 5.53 | 2.49 | 2.65 | 10.67 | 10. | 8 02 | 8. | 9 62 | 2 36 | 2. | 2 12 | 1718 |

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*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. § 2016 and 2020 were analyzed at the request of the manufacturers who claim that Nos. 1968 and 1912 do not truly represent their goods. † Reprinted from Bulletin 50. ‡ Reprinted from Bulletin 51.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| †1746 | GreatEaste'nCorn Phosphate | 0.30 | 0.14 | 1.48 | 2.92 | 3. | $8.18 | 6.63 | 1.97 | 1.40 | 10.00 | 9. | 8.60 | 8. | $9 82 | 2.29 | 2. | $2.06 | 1746 |
| ‡1978 | " " General Fertilizer | 0.21 | 0.14 | 0.61 | 0.96 | 0.8 | 2 69 | 6.74 | 1.63 | 1.12 | 9.49 | 9. | 8.37 | 8. | 9.49 | 4.31 | 4. | 3 88 | 1978 |
| ‡1956 | " " Grass & Oats Fert | - - - | - - - | - - - | - - - | - - - | - - - | 7.53 | 3.52 | 1.34 | 12.39 | - - - | 11.05 | 11. | 12.34 | 2.36 | 2. | 2.12 | 1956 |
| ‡1969 | " " Potato Manure | 0.18 | 0.14 | 2.01 | 2.33 | 2. | 6.52 | 6.23 | 2.10 | 1.73 | 10.06 | 9. | 8.33 | 8. | 9.65 | 4.30 | 4. | 3.87 | 1969 |
| ‡1974 | Lister's AnimalBone&Potash | - - - | - - - | - - - | - - - | - - - | - - - | 7.76 | 1.86 | 0.68 | 10.30 | 10. | 9.62 | 9. | 10.67 | 5.37 | 5. | 4.83 | 1974 |
| 1999 | " Potato Manure No. 1 | - - - | 1.60 | 2.39 | 3.99 | 3.7 | 11.49 | 6.77 | 1.21 | 1.26 | 9.24 | 8.5 | 7.98 | 7.5 | 9.16 | 7.46 | 7. | 6.71 | 1999 |
| 1859 | " Potato Fertilizer No. 2 | - - - | 0.19 | 2.02 | 2.21 | 1.81 | 6.23 | 9.14 | 1.58 | 1.74 | 12.46 | 12. | 10.72 | 9 25 | 12.33 | 4 53 | 2.75 | 4.08 | 1859 |
| 1990 | " Special Potato Fert. | - - - | 0.25 | 1.68 | 1.93 | 1.65 | 5.45 | 7.21 | 1.82 | 2.55 | 11.58 | 9. | 9 03 | 8. | 10.77 | 3 46 | 3. | 3.11 | 1990 |
| †1714 | " Success Fertilizer. | - - - | 0.21 | 1.37 | 1.58 | 1.23 | 4.47 | 8.25 | 1.23 | 2.80 | 12.28 | 11.5 | 9.48 | 9. | 11.43 | 2.21 | 2. | 1.99 | 1714 |
| 1833 | Lowell Animal Fertilizer. | - - - | 0.26 | 2.55 | 2.81 | 2 47 | 7.92 | 5.19 | 2.59 | 0.99 | 8.77 | 8. | 7.78 | 7. | 8.70 | 4 07 | 4. | 3.66 | 1833 |
| 2012 | " Bone Fertilizer | - - - | 0.21 | 2.32 | 2.53 | 2.47 | 7.13 | 4.34 | 4.24 | 1.09 | 9.67 | 6. | 8.58 | 5. | 9.45 | 3.96 | 3. | 3.56 | 2012 |
| 2013 | " Potato Phosphate. | 1.06 | 0.13 | 2.28 | 3.42 | 3 29 | 9.50 | 3.85 | 8.08 | 2.93 | 14.81 | 8. | 11.88 | 7. | 13.44 | 5.91 | 6. | 5.33 | 2013 |
| 2014 | " Vegetable and Vine. | 0.39 | 0.13 | 2.76 | 3.28 | 2.47 | 9.17 | 4.83 | 7.60 | 1.00 | 13.43 | 8. | 12.43 | 7. | 13.31 | 6 48 | 6. | 5.83 | 2014 |
| 1625 | P.G.Co'sHighGradeGen.Fert | 0.62 | - - - | 2.83 | 3 45 | 3.25 | 9.60 | 4.21 | 5.38 | 1.27 | 10.86 | 9. | 9.59 | 8. | 10.52 | 6.95 | 7. | 6.25 | 1625 |
| 1991 | " Nobsque Guano | - - - | - - - | 1.25 | 1 25 | 1.15 | 3.50 | 3.87 | 4.73 | 2.02 | 10.62 | 10. | 8.60 | 8. | 9 80 | 2.10 | 2. | 1.88 | 1991 |
| †1747 | " Soluble Pacific Guano. | 0.34 | 0.16 | 1.71 | 2 21 | 2.25 | 6.19 | 5.68 | 3.68 | 2.13 | 11.49 | 10.5 | 9.36 | 8.5 | 10.77 | 2.37 | 2. | 2.13 | 1747 |

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*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprinted from Bulletin 50. ‡Reprinted from Bulletin 51.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. |  |  |  |  |  | PHOSPHORIC ACID. |  |  |  |  |  |  |  | POTASH. |  |  | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed: | Valuation at Station Prices. |  |
| ‡1958 | P.G.Co's Spec. Potato & Tob. | 0.45 | 0.20 | 1.91 | 2.56 | 2.06 | $7.17 | 5.31 | 3.06 | 2.49 | 10.86 | 9. | 8.37 | 8. | $ 9.90 | 3.19 | 3. | $2.87 | 1958 |
| §1824 | " " " " " | 0.15 | 0.13 | 1.90 | 2.18 | 2.06 | 6.12 | 4.98 | 3.17 | 3.74 | 11.89 | 9. | 8.15 | 8. | 10.14 | 3.12 | 3. | 2.81 | 1834 |
| ‡1758 | Quinnipiac Climax Phosph't | -- - | 0.13 | 1.05 | 1.18 | 1.03 | 3.33 | 4.86 | 3.17 | 1.67 | 9.70 | 9. | 8.03 | 8. | 9.18 | 2.16 | 2. | 1 94 | 1758 |
| †1715 | " Corn Manure.... | 0.29 | 0.14 | 1.90 | 2.33 | 2.06 | 6.51 | 4.56 | 4.12 | 2.92 | 11.60 | 10. | 8.68 | 9. | 10.30 | 1.52 | 1.5 | 1.37 | 1715 |
| 1993 | " Phosphate ...... | 0.33 | 0.18 | 2.35 | 2.86 | 2.47 | 8.01 | 5.60 | 4.33 | 1.93 | 11.86 | 10. | 9.93 | 9. | 11.26 | 2.16 | 2. | 1.94 | 1998 |
| 1909 | " Pine Island Phos. | -- - | -- - | 2.10 | 2.10 | 2.06 | 5.88 | 4.71 | 4.16 | 2.41 | 11.28 | 10. | 8.87 | 9. | 10.31 | 2.63 | 1. | 2.37 | 1909 |
| ‡1759 | " Potato & Tobacco | 0.54 | 0.13 | 1.57 | 2.24 | 2.05 | 6.24 | 5.23 | 3.51 | 2.91 | 11.65 | 9. | 8.74 | 8. | 10.42 | 3.17 | 3. | 2.85 | 1759 |
| 1992 | " Potato Manure.. | 0.78 | 0.16 | 1.78 | 2.72 | 2.47 | 7.57 | 2.56 | 3.95 | 2.08 | 8.59 | 7. | 6.51 | 6. | 7.60 | 5.33 | 5. | 4.80 | 1992 |
| 1722 | " Potato Phosphate | -- - | 0.16 | 2.43 | 2.59 | 2.05 | 7.28 | 4.56 | 4.21 | 2.37 | 11.14 | 9. | 8.77 | 8. | 10.17 | 2.45 | 3. | 2.20 | 1722 |
| 1795 | " Seed'g Down Man | -- - | -- - | 1.16 | 1.16 | 0.82 | 3.26 | 3.64 | 4.91 | 2.34 | 10.89 | 10. | 8.55 | 9. | 9.85 | 2.05 | 2. | 1.84 | 1795 |
| 2011 | Read's Chicopee Corn & Wheat | 0.20 | -- - | 1.55 | 1.75 | 0.82 | 4.89 | 5.58 | 3.08 | 1.31 | 9.97 | 9. | 8.66 | 8. | 9.74 | 1.87 | 1. | 1.68 | 2011 |
| ‡1976 | " Farmers' Friend Super | 0.07 | 0.18 | 1.95 | 2.20 | 2.06 | 6.19 | 7.52 | 2.31 | 1.13 | 10.96 | 10. | 9.83 | 9. | 11.03 | 2.03 | 2. | 1.83 | 1976 |
| ‡1975 | " Fish, Bone & Potash | -- - | 0.18 | 2.57 | 2.75 | 2.47 | 7.74 | 2.85 | 2.46 | 1.78 | 7.09 | 5. | 5.31 | 4. | 6 31 | 4.43 | 4. | 3.99 | 1975 |
| ‡1960 | " Leader Guano....... | 0.18 | -- - | 0.93 | 1.11 | 0.82 | 3.09 | 4.88 | 2.52 | 0.75 | 8.10 | 8. | 7.35 | 7. | 8.13 | 2.48 | 2. | 2.23 | 1960 |
| ‡1961 | " Practical Pot. Special | 0.16 | -- - | 1.07 | 1.23 | 0.82 | 3.43 | 3.18 | 1.89 | 0.61 | 5.13 | 5. | 4.52 | 4. | 5.08 | 8.49 | 8. | 7.64 | 1961 |
| ‡1962 | " Standard Superphos . | 0.12 | 0.18 | 0.95 | 1.20 | 0.82 | 3.37 | 6.15 | 1.75 | 0.95 | 8.85 | 9. | 7.90 | 8. | 8.90 | 4.70 | 4. | 4.23 | 1962 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†Reprint from Bulletin 50. ‡Reprint from Bulletin 51. §Through error, two samples of these goods were analyzed.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation at Station Prices. | Soluble. | Reverted. | Insoluble. | Total Found. | Total Guaranteed. | Available Found. | Available Guaranteed. | Valuation at Station Prices. | Found. | Guaranteed. | Valuation at Station Prices. | |
| 1997 | Read's Vegetable & Vine Fert | - - | - - | 1.95 | 1.95 | 1.64 | $5.46 | 4.81 | 1.78 | 1.05 | 7.64 | 7. | 6.59 | 6. | $ 7.49 | 8.00 | 8. | $7.20 | 1998 |
| 1737 | Standard Fertilizer.......... | 0.41 | 0.16 | 1.61 | 2.18 | 2. | 6.09 | 6.19 | 2.68 | 2.02 | 10.89 | 10. | 8.86 | 8. | 10.30 | 2.33 | 2. | 2.10 | 1737 |
| 1735 | " Guano............ | 0.19 | - - | 1.05 | 1.24 | 1.03 | 3.51 | 3.85 | 4.49 | 2.33 | 10.67 | 10. | 8.34 | 8. | 9.65 | 2.29 | 2. | 2.06 | 1735 |
| §1736 | " Potato & Tobacco. | 0.41 | 0.14 | 1.80 | 2.35 | 2.05 | 6.57 | 5.00 | 4.73 | 2.49 | 12.22 | 9 | 9.73 | 8. | 11.23 | 2.79 | 3. | 2.51 | 1736 |
| 2021 | " " " | 0.67 | - - | 1.56 | 2.23 | 2.05 | 6.18 | 4.74 | 4.00 | 3.26 | 12.00 | 9. | 8.74 | 8. | 10.52 | 3.23 | 3. | 2.91 | 2021 |
| 1895 | Tucker's Imper'l Bone Super. | - - | - - | 1.79 | 1.79 | 1. | 5.01 | 4.78 | 4.88 | 1.82 | 11.48 | 11. | 9 66 | 9. | 10.87 | 1.65 | 1.85 | 1.47 | 1895 |
| §2002 | " Special Potato Fert. | 0.63 | 0.13 | 1.89 | 2.65 | 2.4 | 7.38 | 2 47 | 5.05 | 1.44 | 8.96 | 9. | 7.52 | 8. | 8.34 | 5.55 | 6. | 4.99 | 2002 |
| *2006 | Wheeler&Co.'sCorn Fertlizer | 0.24 | - - | 2.69 | 2.93 | 2.88 | 8.18 | 6.95 | 2.50 | 1.18 | 10.63 | 9. | 9.45 | 8. | 10.62 | 2.30 | 2. | 2.26 | 2006 |
| *2007 | " Grass&Oats.. | - - | - - | - - | - - | - - | - - | 5.68 | 5.57 | 1.50 | 12.75 | - - | 11.25 | 11. | 12.42 | 2.26 | 2. | 2.17 | 2007 |
| *2008 | " Potato Manure | - - | - - | 2.33 | 2.33 | 2.06 | 6.52 | 7.01 | 2.04 | 1.78 | 10.83 | 9. | 9.05 | 8. | 10.46 | 6.07 | 4. | 6.02 | 2008 |
| *2009 | " RoyalWheatGrower | - - | 0.14 | 1.48 | 1.62 | 0.82 | 4.56 | 5.52 | 3.83 | 2.20 | 11.55 | 9. | 9.35 | 8. | 10.78 | 4.06 | 2. | 3 92 | 2009 |
| *2010 | " Superior Truck.... | - - | - - | 3.35 | 3.35 | 3.29 | 9.38 | 5.47 | 2.28 | 1.86 | 9.61 | 8. | 7.75 | 7. | 9.04 | 7.63 | 8. | 7.54 | 2010 |
| ‡1760 | W.&C.Co.'sAmer.Pot.&Tob. | 0.58 | 0.16 | 1.45 | 1.19 | 2.06 | 6.11 | 5.54 | 3.24 | 2.49 | 11.27 | ·9. | 8.78 | 8. | 10.33 | 3.19 | 3. | 2.87 | 1760 |
| 1827 | " Amer.Ammo.B.Sup'r | 0.85 | 0.13 | 1.79 | 2.77 | 2.47 | 7.70 | 5.69 | 3.98 | 2.35 | 12.02 | 10. | 9.67 | 9. | 11.18 | 1.99 | 2. | 1.79 | 1827 |
| †1692 | " " " Corn Phos. | 0.31 | 0.16 | 1.83 | 2.30 | 2.06 | 6.44 | 4.60 | 3.61 | 3.29 | 11.50 | 10. | 8.21 | 9. | 9.99 | 1.59 | 1.5 | 1.43 | 1692 |
| 1826 | " Potato Phosphate. .. | 1.23 | 0.19 | 1.40 | 2.82 | 2.47 | 7.81 | 2.56 | 3.75 | 1.75 | 8.06 | 7. | 6.31 | 6. | 7.27 | 5.74 | 5. | 5.17 | 1826 |
| ‡1761 | " Royal Bone Phos.... | - - | - - | 1.25 | 1.25 | 1.03 | 3.50 | 4.72 | 3.57 | 1.94 | 10.23 | 8. | 8.29 | 7. | 9.54 | 2.16 | 2. | 1.94 | 1761 |

* Potash in brands thus marked is largely, if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 50. ‡ Reprinted from Bulletin 51. § 2021 was analyzed at the request of the manufacturers who claim that No. 1736 does not truly represent their goods.

## III. COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1895 AND IN 1896.

Of the 182 brands of commercial fertilizers sold in the State during 1895 and 1896, and found by our sampling agents, 71 have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands have been chosen which have been found by us both years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1895 AND 1896.

| Name of Ingredient. | 1895. | | 1896. | |
|---|---|---|---|---|
| | Pounds in a Hundred. | Valuation at 1896 Prices. | Pounds in a Hundred. | Valuation at 1896 Prices. |
| Nitrogen | 2.17 | $6.08 | 2.25 | $6.30 |
| Soluble Phosphoric Acid | 5.98 | 6.58 | 5.53 | 6.08 |
| Reverted Phosphoric Acid | 2.46 | 2.46 | 3.20 | 3.20 |
| Insoluble Phosphoric Acid | 2.54 | 1.02 | 2.36 | 0.94 |
| Available Phosphoric Acid | 8.44 | | 8.73 | |
| Total Phosphoric Acid | 10.98 | | 11.09 | |
| Potash | 3.35 | 3.01 | 3.38 | 3.04 |
| Total valuation per ton | | $19.15 | | $19.56 |

A comparison of the average compositions for 1895 and 1896 in the above table shows but little change. There is slight increase in each of the three principal ingredients, nitrogen, available phosphoric acid and potash, the amounts being 0.08, 0.29 and 0.08 per cents. respectively. The increase in valuation is forty-one cents or a little over two per cent.

Judging by Station analyses, the average goods sold in 1894 were of lower composition than those of any year since the Station began sampling and analysing fertilizers. Last year there was slight improvement in this respect, and this year sees a little further advance. The average goods of the past two years contain less nitrogen and available phosphoric acid and more potash than those of previous years, and are worth less on the same scale of valuations. They sell for less it is true, but not as much less as they should considering the decrease in quality and the much lower cost of nitrogenous and phosphatic crude stock.

In this connection the following table showing the average of analyses, selling prices, valuations, percentages of increase of cost over valuation, and valuations of all at 1896 trade values may prove helpful. All brands analysed each year since the Station has had charge of this class of work are included in the comparison, each brand being given equal value in the calculation, which while not strictly correct is the best which can be done in the absence of data showing the consumption of individual brands.

### AVERAGE ANALYSES OF ALL BRANDS.

| | 1885. | 1886 | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | 2.38 | 2.58 | 2.75 | 2.80 | 2.55 | 2.41 | 2.52 | 2.42 | 2.41 | 2.21 | 2.22 | 2.22 |
| Soluble Phosphoric Acid | 6.35 | 6.15 | 5.46 | 6.74 | 6.68 | 5.99 | 6.47 | 6.47 | 6.44 | 5.42 | 5.84 | 5.36 |
| Reverted Phosphoric Acid | 1.93 | 1.92 | 3.28 | 2.80 | 2.97 | 2.97 | 2.86 | 2.60 | 2.84 | 2.97 | 2.56 | 3.44 |
| Insoluble Phosphoric Acid | 2.18 | 2.59 | 2.52 | 2.56 | 2.98 | 2.71 | 2.00 | 2.18 | 2.34 | 2.16 | 2.53 | 2.22 |
| Available Phosphoric Acid | 8.28 | 8.07 | 8.71 | 9.54 | 9.65 | 8.96 | 9.33 | 9.07 | 9.28 | 8.39 | 8.40 | 8.80 |
| Total Phosphoric Acid | 10.41 | 10.66 | 11.25 | 12.10 | 12.63 | 11.67 | 11.33 | 11.25 | 11.62 | 10.55 | 10.93 | 11.02 |
| Potash. | 2.77 | 2.69 | 2.84 | 3.12 | 2.69 | 3.16 | 3.13 | 2.82 | 2.64 | 2.95 | 3.46 | 3.66 |
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| Average selling price | 37.90 | 37.02 | 36.75 | 35.18 | 35.11 | 34.89 | 33.14 | 32.47 | 32.32 | 31.47 | 30.90 | 30.90 |
| Average valuation by each year's price | 26.72 | 25.75 | 27.15 | 28.96 | 29.05 | 26.70 | 26.07 | 24.48 | 23.53 | 21.47 | 21.28 | 19.73 |
| Per cent increase of cost over valuation | 42. | 44. | 35. | 21. | 21. | 29. | 27. | 33. | 37. | 47. | 45. | 57. |
| Valuation by '96 prices | 18.92 | 19.37 | 20.58 | 21.81 | 21.07 | 20.26 | 20.65 | 19.91 | 19.99 | 18.63 | 19.82 | 19.73 |

According to this table the selling price of the average commercial fertilizer sold in Vermont has decreased every year until 1896, when it has remained stationary. This year's inspection has included an unusually large number of high grade, high priced goods, and since in the above table each brand has equal value in the average, the selling price, as well as the average analysis, is higher than it would be if we were able to make calculations giving each brand a value proportionate to its use. A comparison of the selling prices for 1895 and 1896 of the brands most commonly used in the State shows an average decrease of 32 cents per ton in selling price this year. Sixty per cent of these brands sold at lower prices this year than last, and the rest at higher or at the same prices.

The high percentage of increase of cost over valuation during the past three years should be noted in this connection. The cost of mixed goods has decreased, but proportionately the cost of crude stock has lessened still more. The large buyer may well consider whether he can afford to pay 57 per cent of the seaboard value of the unmixed chemicals to the manufacturer for mixing, bagging, freighting and selling the goods. The home mixing system is successfully practiced by many and has much to recommend it. Those desiring information upon methods and results of home mixing should apply for Bulletin 47.

Although the best goods were sold in 1888-89 at higher prices, although the lower prices of the present are not proportionate to the fall in crude stocks, and although manufacturers' charges for manipulating the goods are larger than before, yet a dollar purchases as much plant food this year as at any previous time in the history of the trade in the State. But if former prices were fair, present prices should be lowered, because of the comparative cheapness of fertilizing ingredients. Intelligent study of guarantees, analyses and selling prices, together with due regard to crop performance of the goods in the past will usually result in satisfactory purchase.

## IV. ANALYSES OF MISCELLANEOUS FERTILIZERS.

### ANALYSES OF FERTILIZER CRUDE STOCK.

| Station Number. | MATERIAL. | RECEIVED FROM. | Nitrogen. | PHOSPHORIC ACID. | | | | | Potash. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Soluble. | Reverted. | Insoluble. | Total. | Available. | |
| | | *Nitrogenous and Phosphatic.* | | | | | | | |
| 1560 | Tankage.......... | Great Eastern Fert. Co., Rutland | 8.26 | | | | 9.85 | | |
| 1599 | " ........ | Robertson & Shiland, Burlington | 4.11 | | | | 11.51 | | 1.24 |
| 1600 | " ........ | " " " | 4.24 | | | | 14.74 | | |
| 1608 | " ........ | " " " | 3.60 | | | | 13.50 | | |
| 1609 | " ........ | " " " | 3.10 | | | | 11.80 | | |
| 1561 | Ground Bone.... | Great Eastern Fert. Co., Rutland | 4.22 | | | | 25.41 | | |
| 1589 | " " .... | L. G. B. Cannon, Burlington...... | 4.42 | | | | 13.88 | | |
| 1574 | " " .... | Nathan Way, West Burke........ | 2.99 | | | | 26.56 | | |
| 1575 | CresentGro'ndB'n | " " " " .... | 3.04 | | | | 15.75 | | |
| | | *Phosphatic.* | | | | | | | |
| 1564 | Acid Phosphate.. | Great Eastern Fert. Co., Rutland | | 13.52 | 2.32 | 0.22 | 16.06 | 15.84 | |
| 1581 | " " .. | C. W. Webster, East Roxbury.... | | 7.61 | 4.04 | 3.04 | 14.69 | 11.65 | |
| 1610 | NaturalPlantFood | H. A. Bixby, Burlington.......... | 0.18 | | | 9.48 | 19.15 | 9.67 | 0.18 |
| 1614 | Grn'dSo.Car.Rock | Geo. Cassie, Barre................ | | | | | 25.18 | | |
| | | *Potassic.* | | | | | | | |
| 1548 | Muriate of Potash | Great Eastern Fert. Co., Rutland | | | | | | | 49.17 |
| 1578 | " " | Nathan Way, West Burke........ | | | | | | | 49.50 |
| 1580 | " " | C. W. Webster, East Roxbury.... | | | | | | | 49.72 |

Station Nos. 1599–1600–1608–1609. The low grade of these goods is due to their being somewhat wet and to incomplete extraction of fat.

Station No. 1610. This material is probably either Pamunkey Phosphate, a soft marl-like material mined in Virginia, or a Florida soft phosphate. It contains practically nothing but phosphoric acid. Although yielding about one-half its phosphatic contents to the chemist's solvents as "available," it is advised to use sparingly at first as its availability to plant growth is not yet definately settled.

## ANALYSES OF ASHES.

| Station Number. | SOURCE. | RECEIVED FROM. | Soluble Potash. | Insoluble Potash. | Total Potash. | Total Phosphoric Acid. | Insoluble Matter. | Lime. |
|---|---|---|---|---|---|---|---|---|
| 1562 | | C. F. Tillotson, Morrisville. .. | 1.57 | 2.93 | 4.50 | 2.08 | 30.00 | |
| 1570 | Tannery.. | Albert Sargent, Brookfield.... | 2.69 | 0.97 | 3.66 | 3.56 | | |
| 1571 | Vermont . | " " " .... | 7.07 | 2.66 | 9.73 | 4.40 | | |
| 1572 | Canada .. | W. H. Hutchinson. Braintree | 2.69 | 2.78 | 5.47 | 2.79 | | |
| 1576 | Lime Kiln | W. B. Fonda, St. Albans... . | 1.38 | 0.84 | 2.22 | 0.89 | | |
| 1582 | Canada .. | L. G. B. Cannon, Burlington. | 3.58 | 2.51 | 6.09 | 1.59 | | 30.52 |
| 1584 | " | R. Millen, Westminster West. | 2.70 | 1.20 | 3.99 | 3.19 | | |
| 1585 | " | L. G. B. Cannon, Burlington. | 5.17 | 1.52 | 6.69 | 1.73 | | 31.36 |
| 1586 | Unleach'd | Ida Mann, Randolph .......... | 4.58 | 1.57 | 6.17 | 1.76 | | |
| 1587 | Leached.. | " " .......... | 1.21 | 0.82 | 2.02 | 1.49 | | |
| 1588 | | G. F. Tanner, Springfield .... | 3.36 | 1.89 | 5.25 | 1.13 | | |
| 1597 | | C. M. Stebbins, Wolcott....... | 6.05 | 2.59 | 8.64 | 2.82 | | |
| 1513 | Lime Kiln | Geo. Cassie, Barre.... ....... | 3.71 | 1.66 | 5.37 | 1.14 | 8.89 | 39.87 |

Thirteen samples of ashes varied from 1.21 to 7.07 per cent. soluble potash and from 0.89 to 4.40 per cent. total phosphoric acid. Disregarding the effect, chemical or mechanical, of other ingredients, and taking into account only the three ingredients stated, soluble and insoluble potash and total phosphoric acid, the best ashes were nearly five times as good as the poorest. The prices of this class of goods is not always in accordance with quality. It is best to buy on Experiment Station analysis. Some dealers sell subject to discount in case Station analysis shows deficiency.

### ANALYSES OF MUCK.

| RECEIVED FROM. | ORIGINAL SUBSTANCE. Moisture. | Ash. | Organic and Volatile Matter. | Nitrogen. | DRY MATTER. Ash. | Organic and Volatile Matter. | Nitrogen. |
|---|---|---|---|---|---|---|---|
| C. M. Densmore, Jamaica | 89.57 | 0.36 | 10.07 | 0.19 | 3.45 | 96.55 | 1.83 |
| " " " | 84.33 | 0.35 | 15.32 | 0.22 | 2.23 | 97.77 | 1.40 |
| E. C. Orvis, Manchester | 39.20 | 26.14 | 34.66 | 1.22 | 42.97 | 57.03 | 2.00 |
| " " " | 65.20 | 24.97 | 9.83 | 0.37 | 71.76 | 28.24 | 1.07 |
| " " " | 83.87 | 2.85 | 13.28 | 0.51 | 17.70 | 82.30 | 3.03 |
| A. B. Stoddard, West Burke | 79.43 | 4.40 | 16.17 | 0.56 | 21.39 | 78.61 | 2.74 |
| John Spooner, Enosburgh | 83.08 | 1.78 | 15.14 | 0.42 | 10.52 | 89.48 | 2.52 |
| M. R. Robbins, Brattleboro | 33.85 | 16.30 | 49.85 | 1.33 | 24.64 | 75.36 | 2.01 |
| C. I. Smith, McIndoes Falls | 48.56 | 41.46 | 9.98 | 0.41 | 80.06 | 19.94 | 0.80 |
| " " " | 71.48 | 10.09 | 18.43 | 0.62 | 35.39 | 64.61 | 2.16 |
| " " " | 48.10 | 38.89 | 13.01 | 0.49 | 74.94 | 25.06 | 0.94 |
| C. M. Stebbins, Wolcot | 77.01 | 15.59 | 7.41 | 0.24 | 67.80 | 32.20 | 1.04 |
| M. F. Sullivan, St. Albans | 63.50 | 1.99 | 34.51 | 0.79 | 5.44 | 94.56 | 2.16 |
| C. M. Scarff, Burlington | 29.51 | 18.52 | 51.97 | 1.46 | 26.29 | 73.71 | 2.07 |

Fourteen samples of muck varied from 0.80 to 3.03 per cent. nitrogen in dry matter. Those containing small amounts of nitrogen were usually full of sand and earth, as shown by high ash percentages.

### ANALYSES OF "COMPLETE" FERTILIZERS.

| Station Number. | MATERIAL. | RECEIVED FROM. | Nitrogen. | PHOSPHORIC ACID. Soluble. | Reverted. | Insoluble. | Total. | Available. | Potash. |
|---|---|---|---|---|---|---|---|---|---|
| 1565 | "Light" | Loudeville Bros., Williston | 1.58 | 3.55 | | 8.65 | 12.20 | | 2.26 |
| 1566 | "Dark" | " " " | 1.37 | 7.84 | | 2.95 | 10.79 | | 2.39 |
| 1546 | | | 1.48 | 6.30 | | 3.36 | 9.66 | | 2.43 |
| 1591 | Lister's Success | R. L. Stickle, Shaftsbury | 1.74 | 6.86 | 1.24 | 3.04 | 11.14 | 8.10 | 2.40 |
| 1605 | Bowker's Flower Food | Rutland Fire Clay Co Rutland | 6.65 | 9.79 | 1.22 | 0.94 | 11.95 | 11.01 | 3.67 |

Station Nos. 1565–1566. The parties sending these samples claimed them to be fairly representative of goods sold them as one and the same thing and under one brand. One was of a light and the other of a dark color. Analyses showed similarity in nitrogen and potash percentage but considerable difference in total phosphoric acid. No. 1546 is the analysis of the officially taken sample from the dealer's stock from which it is claimed that the goods in question were bought.

### ANALYSES OF MISCELLANEOUS FERTILIZING MATERIAL.

| Station Number. | MATERIAL. | RECEIVED FROM. | Nitrogen. | Total Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|
| 1567 | Home-Made Fertilizer | E. H. Hallett, St. Johnsbury Ctr. | 0.32 | 0.46 | 0.00 |
| 1568 | " " | " " " " | 0.28 | 0.39 | 0.00 |
| 1569 | " " | " " " " | 0.45 | 0.39 | 0.00 |
| 1598 | Refuse Meat Cake .... | M. A. Nott, Burlington.......... | 6.30 | 1.54 | - -- |
| 1604 | Rock.................. | J. T. Whitlock, Brandon ........ | - -- | 0.14 | 0.84 |
| 1407 | "Ameola"............ | Geo. Cassie, Barre................ | 2.14 | 1.41 | 0.28 |

Station Nos. 1567–1568–1569. These goods were made from fresh meat, bones, fish scraps and sand, and are considerably less valuable weight for weight than barn-yard manure.

Station No. 1604. This material was claimed to have been found beneficial as a fertilizer. The same amount of phosphoric acid and potash as is present in a ton of this material may be bought in the best forms for 46 cents.

Station No. 1607. It is claimed that "Ameola" is a natural product dredged from the bottom of a deep lake in Southern Florida. The same amounts of plant food in the best forms may be bought at prices lower than those quoted with this sample to the party sending it to the Station.

1896.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 53.

AUGUST, 1896.

## The Pollination of Plums.

I. Summary. (Page 47).
II. Common Orchard Observations. (Pages 48–49).
III. Cross-Pollination and Fruitfulness. (Pages 49–50).
IV. Cross-Pollination in Plums. (Pages 50–56).
V. Botanical Relationships of Plums. (Pages 57–62).
  1. Conspectus of Cultivated and Native Species. (Pages 57–59)
  2. Remarks upon Botanical Groups. (Pages 59–62).
VI. Quoted Opinions and Observations. (Pages 62–64).
VII. Queries. (Page 64).

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1896.

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Offices and laboratories are at Experiment Station building, corner Main Street and University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# THE POLLINATION OF PLUMS.

By F. A. WAUGH.

## I. SUMMARY.

**II. Plums are very uncertain in setting fruit. A part of this uncertainty seems to be due to lack of proper cross-pollination. To secure cross-pollination plums of different varieties should be closely planted, or scions of different varieties should be set into the tops of trees which do not bear satisfactory crops of fruit. (Pages 48-49.)**

**III. Cross-pollination is an important factor in determining the crops of pears, apples, grapes, strawberries and other fruits. (Page 49.)**

**IV. Cross-pollination in plums is provided for by several natural adaptations, especially by the defectiveness of flower parts and by the sterility of certain varieties toward their own pollen (Pages 50-56.)**

**V. American varieties of cultivated plums have arisen from several distinct botanical species. These varieties retain more or less the characters of the parent species, and thus may be judged to some extent by their parentage It is thought that the botanical relationships of varieties will prove to be the best guide to their affinities in cross-pollination. (Page 57.)**

**The economic characters of these groups may be generalized as follows:**

**European; (Prunus domestica); hardy; best and most salable fruit; perfect pistils; not good pollen bearers. (Page 59.)**

**Myrobolan; used as stock, but losing in favor, being supplemented by Marianna and Americana varieties. (Page 59.)**

**Japanese; comparatively new; relative value uncertain; several varieties practically hardy. (Page 59.)**

**Americana group; the Western wild plum; very hardy; fruit good but inferior to European; good stocks; very delicate sexually; usually requires cross-pollination. Eastern forms (var. nigra) are even more hardy than Western forms; range further north; stronger pistils; weaker pollen bearers. (Page 59.)**

**Wild Goose Group; about as hardy as Japanese plums; thought to need cross-pollination and to be weak pollen bearers. (Page 61.)**

**Marianna; probably a hybrid; sexually weak; uncertain bearer; chiefly used as stock (Page 61.)**

**Chicasaw; of Southern origin; doubtfully hardy in Vermont; many prolific and desirable varieties. (Page 61.)**

**VI. Eminent horticulturists and botanists agree in the general desirability of cross-pollination in plums. (Pages 62-64.)**

**VII. Although we have gained some knowledge as to the pollination of plums, there are yet many questions of practical importance and theoretical interest open to investigation. It is hoped that this bulletin will call attention to some of these unanswered questions and direct the reader to further observation and reflection. (Page 64.)**

## II. COMMON ORCHARD OBSERVATIONS.

Among the multitudinous uncertainties of fruit growing the production of a crop of plums presents the greatest combination of obscure and unmanageable factors. Even if a heavy crop of fruit is set, the curculio, the gouger and the brown rot—all peculiarly hard of suppression—remain between it and the market. But there are many uncertainties in the setting of the crop. At times plum trees are so greatly overloaded with fruit that the branches may be broken to the ground. Other varieties, or the same varieties in different localities, or the same trees in different years may show hardly any fruit. Moreover this condition of varying fruitfulness is largely independent of the crop of blossoms which the trees may produce. Plums are notably prolific bloomers ; yet many trees are loaded with blossoms year after year without the smallest result in fruit. A crop of plum blossoms is no satisfactory indication of a crop of plums.

These are matters of common remark. Observant orchardists have long ago learned to shun unproductive varieties and to destroy the more nearly sterile trees. More recently it has become customary to refer cases of total or partial sterility to lack of cross-pollination, and, proceeding on

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NOTE. Following the better usage of the present day, the term "fertilization," and all its derivatives have been discarded as far as possible, and the terms "pollination" and "fecundation" substituted. Pollination refers to the application of the pollen to the stigma of a flower, whether naturally or artificially accomplished. Fecundation applies to the actual union of the reproductive substance in the pollen grain with the egg-nucleus of the young seed or ovule. Thus fecundation may or may not follow pollination. The term fertilization may sometimes be useful in referring to both processes together, or in cases where it is desirable not to make a distinction between the two. For a discussion of this subject see Proceedings Madison Botanical Congress, 1893, page 34.

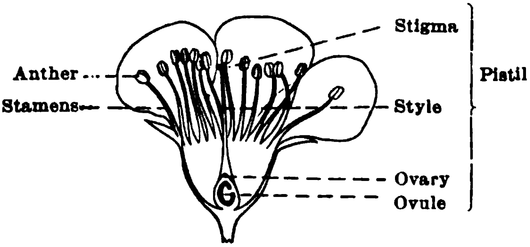

FIGURE 1. DIAGRAM OF PLUM BLOSSOM.

NOTE. Reference to the accompanying cut may help some readers to understand certain terms necessarily used in this bulletin. The pollen, or "pollen dust," is the (usually) yellow dust borne within the anthers. An anther is one of the little pollen sacks taken by itself. An anther with the slender stem supporting it constitutes a stamen. The pistil is made up of the stigma, the style, and the ovary. The stigma receives the pollen when pollination takes place. The style is merely the stem between the stigma and the ovary. The ovary contains the seed or seeds ; and, in the case of the plum, enlarges to make the fruit.

this theory, mixed planting and the inter-grafting of different varieties have been frequently advised and practiced. Cases which lend support to this theory will occur to almost every horticulturist. Mr. L. M. Macomber of North Ferrisburgh, Vt., has a tree of naturalized plum from Minnesota (the typical *Prunus Americana*), which blossomed heavily each spring but did not bear a fruit for several years. Later a tree of another variety standing near it began to blossom. The first year after the blossoming of the Lawrence, and each succeeding year, the Minnesota plum bore heavy loads of fruit. Similar cases could be cited indefinitely.

## III. CROSS-POLLINATION AND FRUITFULNESS.

The influence which cross-pollination is assumed to have in the increased number of plums set in certain cases, is analagous to that which has been shown to exist with many other plants. Cross-pollination (or cross-fertilization) is associated in the popular mind with the production of wonderful new varieties of fruits, flowers and vegetables,—with hybrids and colored plates and fruit-tree agents. But in the light of more thoughtful study it seems doubtful whether this is the chief role which nature intended for cross-pollination, or whether, indeed, it is a natural role at all. It seems rather that cross-pollination has its best usefulness in its immediate effects in provoking certain flowers to bear fruit which otherwise would have been abortive, or in stimulating certain fruits to a more perfect development than they would attain through self fecundation. Waite* has recently shown the importance of cross-pollination with certain varieties of pears; and the same author says:† "Apples are more inclined to be sterile to their own pollen than pears. With the former in the great majority of cases, no fruit resulted from self-pollination." Beach‡ has shown that several varieties of grapes are more or less self-sterile; and Green‖ has added some useful notes in the same line. Bailey§ asserts that our native plums "do not fertilize themselves;" and the experiments of Heideman¶ with varieties of *Prunus Americana* indicate not only frequent self-sterility but also a remarkably capricious selective affinity among certain varieties. It is in the A, B, C of strawberry culture that certain varieties normally bear pistillate blossoms which require pollination from other varieties; and that certain other sorts are particularly useful for the quantity and prepotency of their pollen. It seems possible, or even probable, that when we have gone a little deeper into the question of the pollination of apples, pears and plums, we will designate their sexual capabilities and affinities as positively as we do now those of the strawberry. It is evident that when our knowledge of these fruits gains that degree of exactness we will have made a great advance in pomology. In the meantime we may regard it as the soundest practice to plant plum trees thickly together and to see that the varieties are well mixed.

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* M. B. Waite, The Pollination of Pear Flowers, Bull. 5, Div. Veg. Path., U. S. Dep. Ag.

† Ibid. p. 81.

‡ S. A. Beach, Notes on Self-Pollination of the Grape, N. Y. State Sta. Rpt. 1892, p. 597. Impotency of Grape Pollen, Garden and Forest, 1893, p. 199.

‖ S. B. Green, Cross-Fertilization of Grapes, Minn. Exp. Sta. Bull. 32, p. 229.

§ L. H. Bailey, Cultivation of the Native Plums, Cornell Exp. Sta. Bull. 38, p. 43.

¶ C. W. H. Heideman, The Sexual Affinities of *Prunus Americana*, Minn. Hort. Soc. Rept. 1895, p. 187.

## IV. CROSS-POLLINATION IN PLUMS.

Cross-pollination is advantageous to many varieties of plums, and necessary to at least a few. This preference for foreign pollen is not confined to the blossoms of cultivated varieties, but shows itself quite unmistakably in many wild plums. The aboriginal forms of *Prunus Americana* seem to be especially delicate in their capabilities of fecundation. To meet this need plums do not naturally depend alone on the chance transfer of pollen by insects or wind, but cross-pollination is provided for and self-pollination is provided against by various interesting modifications of the typical flower.

The form of the flower may be changed. There are possible six distinct variations.[*] In two of these the pollen and stigma mature at different times; in two forms the pistils are either much shorter or much longer than the stamens; and in two the flowers are sexually imperfect, one or the other of the essential organs being defective.

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[*] These forms are classified by Darwin in "Different Forms of Flowers in Plants of the Same Species," and the classification has been recently applied to plums by Heideman in his article on "The Sexual Affinities of *Prunus Americana*," referred to elsewhere. They are as follows:

I. Those in which the stigmas and the pollen mature at different times,—*Dichogamous.*
    a. Those in which the stigma has passed the receptive stage before the pollen matures,—*Proterogynous.*
    b. Those in which the pollen ripens before the stigma is receptive,—*Proterandrous.*
II. Those in which the pistils are either much longer or much shorter than the stamens,—*Heterostyled.*
    a. Those in which the pistils are much longer than the stamens,—*Long-styled.*
    b. Those in which the pistils are much shorter than the stamens,—*Short-styled.*
III. Those bearing flowers sexually imperfect,—*Bisexual.*
    a. Those in which the pistils are normal, but the anthers defective,—*Gynodiœcious.*
    b. Those in which the anthers are normal, but the pistils defective,—*Andromonœcious.*

According to my own observations the proterogynous forms are relatively common in the Western wild plum, the typical *Prunus Americana*, and its varieties. Proterandrous forms are infrequent and not pronounced, though Professor Sargent, who makes *Prunus nigra* separate from *P. Americana*, mentions proterandry as characteristic of that species. Long-styled forms are rather frequent, but I have not seen the short-styled forms outside *Prunus Virginiana* and *P. serotina.*

The gynodiœcious form I have never seen, nor any pronounced suggestion of it; though the andromonœcious form is very common both in *Prunus Americana* and *P. Chicasa.* It is only less common among varieties of the Wild Goose group, and may be found among the Japanese varieties, or even among the varieties of *Prunus domestica*, where it is most unusual. The Marianna plum is also often andromonœcious. A very large proportion of blossoms rated in the succeeding tables as having defective pistils, belong to this class.

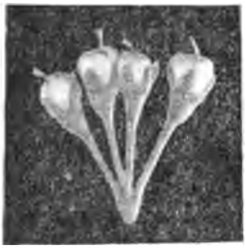

FIGURE 2. BLOSSOM OF WILD PLUM, *Prunus Americana*, SHOWING PROTEROGYNY.

Any one of these arrangements in a blossom usually renders it incapable of self-fecundation. It is probable that each of these six forms occasionally appears in plum blossoms, particularly in varieties of the Americana group; but, aside from the one bearing imperfect pistils, I am inclined to believe that these diversities have little immediate significance. They may be of some slight interest to theoretical biology in throwing some light on questions of evolution, but they are so infrequent as to have no perceptible influence on the fruit crops. The several special modifications would need to be much more uniform in their occurrence than I have found them before they could be considered a safe guide to the affinities of varieties for cross-pollination as suggested by Mr. Heideman. The efficacy of these various forms in securing cross-pollination is yet awaiting demonstration. In the very marked case of proterogyny, illustrated from a photograph in Figure 2, the pistils were protruding through the closed petals at least five days before the pollen was ready on the same blossoms, and six days before pollen was ripe on any other trees in the orchard. The stigmas appeared to be receptive all the while, yet these trees are bearing a heavy load of plums. Moreover, a few of the artificially covered blossoms on these trees set fruit.

Without reference to adaptations for cross-pollination, it is to be remarked that the species *Prunus Americana* is exceedingly variable in all its characters, especially in its flower parts. A form which always bears flowers without petals, which was sent from Ottawa, Canada, is shown in Figure 3. Mr. Heideman mentions a tree in his orchard which uniformly bore flowers with twin ovaries, or even with three united ovaries in a single blossom; and a case of the same sort has come under my own observation in a scion of a "Minnesota" seedling in the orchard of Mr. L. M. Macomber.

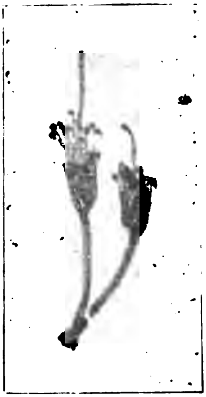

FIGURE 3. ABNORMAL BLOSSOMS OF WILD PLUM, *Prunus Americana*. LONG-STYLED AND APETALOUS.

The defectiveness of pistils in many blossoms, however, seems to me to be a more serious matter. It is of much more frequent occurrence and appears to represent, in a majority of cases, a diseased or atrophied condition of the pistil, rather than a healthy modification of form. Professor Goff, who has given this question diligent study, is inclined to attribute many cases of defective pistils to inclemencies of climate, and an examination of the abortive organ itself would give rather that idea than the notion of a definite evolutionary modification. However, the theory of damage from cold weather is not supported by the notes which we have collected, as will appear later.

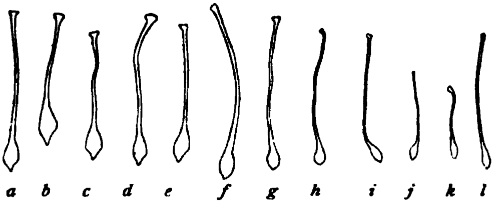

FIGURE 4. TYPICAL PLUM PISTILS. *a*, LOMBARD; *b*, GOLIATH; *c*, YELLOW EGG; *d*, PURPLE DAMSON; *e*, COE'S GOLDEN DROP; *f*, IMPROVED GREEN GAGE; *g*, MOORE'S ARCTIC; *h*, *Prunus Americana*; *i*, *P. Americana*, VAR. *nigra*; *j*, WYANT; *k*, MOREMAN: *l*, WEAVER.

With a view to gaining some light on these questions a large number of plum blossoms have been examined this spring. While the number of blossoms examined from any single sample was too small to warrant any dogmatic judgment of the variety represented, the total number of blossoms examined, (about 2,000) and the careful manner in which the work was done, under the microscope in the laboratory, will justify us in making some generalizations from the whole. The record of these laboratory examinations will be subsequently published in an annual report.

The term "defective pistils" in this bulletin includes all imperfections which evidently would make fecundation impossible. In very many cases no trace of style or ovary was to be found. In many other blossoms a small, rudimentary pistil was present, which had plainly ceased to have any vital significance. These several defects seem, for the most part, to be only degrees of the same weakness, whether that weakness be sexual invalidity, evolutionary adaptation, the result of severe weather, or something else. In the aggregate the defective pistils are numerous enough to be taken into serious consideration.

In the laboratory examinations several samples showed 100 per cent defective pistils. Obviously no crop can be expected from trees which these samples fairly represent. Cases in which trees fail to set fruit after being loaded with blossoms will be remembered by every horticulturist. Doubtless many such instances of sterility occur through lack of pistils. The Marianna is notably a shy bearer. Its record, as shown in Table I seems to show a reason. Its evident sexual weakness may also be some confirmation of its hybrid origin.

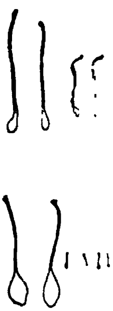

FIGURE 5. SOUND AND DEFECTIVE PISTILS. *Prunus Americana.*

The differences in the average percentages of defective pistils in the several groups can not be regarded as purely accidental. The comparison may best be seen in Table I.

TABLE I. COMPARISON OF GROUPS

In the Matter of Defective Pistils.

| GROUP. | Samples. | Total Blossoms. | Per Cent Defective. |
|---|---|---|---|
| Prunus Americana, varieties | 60 | 550 | 27.8 |
| Prunus Americana, type, wild | 7 | 85 | 40.0 |
| Prunus Americana, var. nigra | 6 | 53 | 5.7 |
| Prunus Americana, consolidated | 73 | 688 | 27.6 |
| Prunus Chicasa, | 17 | 159 | 15.1 |
| Prunus hortulana, varieties | 18 | 171 | 24.6 |
| Marianna | 4 | 46 | 50.0 |
| Prunus domestica, varieties | 30 | 293 | 5.1 |
| Prunus triflora, varieties | 9 | 72 | 15.9 |

From this it appears that about one-half of the pistils of the Marianna were defective; over one-fourth in *Prunus Americana*, (the common wild plum), only a little less in *Prunus hortulana*, (the Wild Goose group), about one-sixth in the Chicasaws and Japanese plums, and only one-twentieth in the European varieties (*Prunus domestica.*) The great discrepancy between the wild forms of the typical *Prunus Americana* (mostly Western) and the variety *nigra*, (mostly Eastern) is a point of considerable interest. Besides furnishing another character in justification of a division between the two forms, it gives a valuable hint to those who are looking for new garden varieties. It is worth remarking, however, in this connection that the variety *nigra* does not bear so much pollen as the type forms.

Some of the individual records in the laboratory examinations are open to more or less explanation. For example, Mr. Munson writes concerning a Wild Goose Seedling (*Prunus hortulana*), which showed 87.5 per cent. defective pistils: "It is only two years old from seed, and is flowering for the first time. It is my experience that, almost invariably, varieties when they begin to bloom set little or no fruit. As they get age some become very fruitful, while others always fruit scatteringly. The youth of this tree, I think, fully accounts for the defectiveness of the female parts." It seems impossible, however, with present data, to find any constant connection between defectiveness of pistils and conditions of soil, cultivation or climate. It should be noted that the same tree varies from year to year. The pistils may be all defective one year, and all sound the next.

Different varieties vary greatly in the amount of pollen produced. This variation seems also to follow somewhat the specific parentage of the varieties. Thus plums of the Americana group are generally more abundant pollen bearers. The Chicasaw plums are rather weaker pollen bearers, though they seldom show serious deficiency. The Japanese plums are still weaker, while the Marianna is distinctly lacking in the quantity, and perhaps also in the quality of pollen produced.

A comparison of the several groups as pollen bearers, is made in Table II.

TABLE II. COMPARISON OF GROUPS

In the Matter of Pollen Bearing. Figures Indicate the Number of Samples Under Each Rating.

| GROUP. | Scant. | Medium. | Abundant. | Very Abundant. |
|---|---|---|---|---|
| Prunus Americana, consolidated | 7 | 23 | 20 | 10 |
| Prunus Chicasa, varieties | 5 | 6 | 3 | 0 |
| Prunus hortulana, varieties | 2 | 11 | 3 | 2 |
| Marianna | 3 | 0 | 0 | 0 |
| Prunus domestica, varieties | 6 | 7 | 7 | 0 |
| Prunus triflora, varieties | 4 | 4 | 0 | 0 |

In connection with any estimates on the point of comparative pollinating efficiency several things have to be taken into account. In the first place any estimate of the quantity of pollen borne must necessarily be very rough. In the second place there may be a difference in the quality of the pollen. I have examined some samples in which many imperfect grains could be noted with a low power lens. In other samples apparently well formed grains would fail to respond to micro-chemical tests for protoplasm (Millon's reagent), leaving a strong presumption against their ability of fecundating the ovules. But above all this, the pistils of many varieties appear to have a pronounced selective ability whereby they refuse certain pollen while receiving readily pollen from some other source. Our knowledge is very imperfect on all these points, but we know enough to make us very cautious how we dogmatize about this question. Much more careful field experimentation is needed along these lines.

In order to gain some evidence on the point raised by Professor Goff and others, that the severe Northern climates are accountable for much of the defectiveness of plum pistils, Table III. has been prepared.

The different locations are arranged in the table, as far as practicable, in the order of their geographical latitude. The testimony of the table is not very emphatic, it is true, but it does not sustain the conjecture. Aside from a uniformly high percentage of defective pistils at Madison, Wisconsin—Professor Goff's own location—the percentage rather decreases than increases northward.

TABLE III. COMPARISON OF LOCALITIES.

Showing Percentage of Defective Pistils.

| LOCALITY AND DATE OF FLOWERING. | Prunus Americana. | | | | | Prunus Chicasa. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Wild | De Soto | Weaver | Wyant | Wolf | Robinson | Pottawattomie | Wild Goose | Marianna |
| Denison, Texas, March 24 | | | 75 | | | | | 25 | |
| Stillwater, Okla., March 31 | 50 | | | | | | | 10 | |
| Manhattan, Kansas, April 18 | 40 | | 0 | 0 | | 20 | | | |
| St. Louis, Mo., April 14 and 21 | 56 | | | | | | | 0 | |
| Morgantown, W. Va., April 22 | 0* | | | | | | | | |
| State College, Penn., April 25 | 0* | | | | | | | | |
| Amherst, Mass., May 4 | 0 | | 0 | | 80 | | 0 | | 67 |
| Agricult'al College, Mich., May 1 | | 10 | | | 22 | | 0 | | |
| Geneva, New York, April 30 | | 0 | | | | | | | |
| Madison, Wisconsin, May 2 | 90 | | | 60 | 56 | 29 | 0 | 9 | 100 |
| Minnesota City, Minn., May 1 | | 14 | 0 | 28 | 37 | | | | |
| Burlington, Vermont, May 8 | 0* | 16 | | | 10 | 0 | 50 | | 0 |
| Orono, Maine, May 19 | | | | | 0 | | | | 17 |
| Ottawa, Canada, May 10 | 0 | 10 | | 10 | | | | | |

*Var. *nigra*.

The first, and perhaps the chief, practical question to be settled is, what varieties, under ordinary circumstances, are fertile with their own pollen, and which are self-sterile? A large number of blossoms in the orchards of Mr L. M. Macomber, North Ferrisburgh, Vt., were covered with paper sacks in order to protect them from cross-pollination. The results from these are shown in Table IV.

TABLE IV. RECORD OF PROTECTED BLOSSOMS.

| VARIETY. | Approximate Number of Covered Blossoms. | Fruits Set. | Crop Set on Remainder of Tree. |
|---|---|---|---|
| De Soto | 25 | 0 | Moderate |
| "De Soto, Wrong" | 75 | 0 | Moderate |
| "Original Minnesota" | 100 | 0 | Moderate |
| "Minnesota" | 100 | 10 | Moderate |
| "Minnesota" Seedling No. 2 | 250 | 6* | Full |
| "Minnesota" Seedling No. 3 | 80 | 4* | Full |
| Pottawattomie | 200 | 0 | Light |
| Robinson | 60 | 8 | Moderate |
| Rollingstone | 200 | 0 | Full |
| Wolf | 200 | 9 | Moderate |
| Wolf Seedling No. 5 | 75 | 5* | Full |
| Wolf Seedling No. 6 | 300 | 0 | Full |
| Wolf Seedling No. 7 | 125 | 6* | Moderate |
| Wolf Seedling No. 2 | 100 | 4* | Full |

*Weak.

The range of varieties in this series of experiments is barely large enough to be suggestive, although the large number of blossoms covered and the relatively small number of fruits set give a satisfactorily clear cut indication of a generally prevalent self-sterility. It seems clear that one could expect little fruit from De Soto, the "Original Minnesota," Pottawattomie. Rollingstone, and the Wolf Seedling No. 6, unless the trees were favorably situated for cross-pollination. It fact Robinson was the only variety in the experiment with which the fruit set by self-pollination seemed to be normal and vigorous. Our judgments made in the orchard—and such judgments may properly go beyond the numbers in the tabulations—were that self-fertility was extremely doubtful in all cases except that of Robinson.

The question which naturally comes next in order, is this : If a certain variety must have foreign pollen in order to set fruit, what other varieties are the most efficacious pollen bearers? This is a question requiring very many experiments in artificial pollination. Our own work for 1896 has been limited to twenty-one experiments among eleven varieties, and consisted of 319 artificial crosses. The record of these pollinations is seen in Table V.

TABLE V. RECORD OF CROSSES.

| | FEMALE PARENT. | | MALE PARENT. | | Number Pollinated. | Number Set. |
|---|---|---|---|---|---|---|
| | Species. | Variety. | Species. | Variety. | | |
| 1 | P. Americana | "Minnesota," | | Cherry, | 18 | 0 |
| 2 | " | " | P. Americana, | nigra, | 85 | 16 |
| 3 | " | " | " | " | 9 | No record. |
| 4 | " | " | " | " | 22 | " |
| 5 | " | " | " | " | 26 | 19 |
| 6 | " | " | " | " | 20 | 2 |
| 7 | " | " | " | " | 12 | 9 |
| 8 | P. Chicasa, | Robinson, | " | "Minnesota," | 16 | 6 |
| 9 | " | " | " | Rollingstone, | 22 | No record. |
| 10 | " | " | " | Wolf, | 14 | 1 |
| 11 | P. Americana, | De Soto, | " | " | 12 | Tree died. |
| 12 | " | " | " | Marianna, | 14 | " |
| 13 | " | " | " | Rollingstone, | 14 | " |
| 14 | " | " | " | " | 27 | " |
| 15 | " | " | " | nigra, | 6 | " |
| 16 | P. Chicasa, | Robinson, | " | " | 9 | 0 |
| 17 | P. Americana, | Wolf, | P. domestica, | McNiel, | 10 | 0 |
| 18 | " | De Soto. | P. Americana, | Wolf Sdlg. | 8 | No record. |
| 19 | " | " | P. domestica, | McNiel, | 5 | 1 |
| 20 | " | Wolf Seedling | P. Americana, | Hawkeye, | 9 | No record. |
| 21 | " | De Soto, | " | Wyant, | 16 | 6 |

Beyond an indication that the typical Western forms of *Prunus Americana* can be pollinated by the Eastern forms,—var. *nigra*—these experiments show nothing. No one who has had experience in hand pollinations will be surprised at the irregularity of results nor at the comparatively small number of fruits set.

## V. BOTANICAL RELATIONSHIPS OF CULTIVATED PLUMS.

Within the past few years it has become customary among nurserymen and fruit growers to refer all cultivated plums to the botanical species from which they are severally supposed to have sprung. This method has many obvious advantages. The cultivated varieties of each group have many important characters in common, so that the fruit grower soon finds himself able to form a very good and useful estimate of any new variety as soon as he knows its botanic origin. However, with the rapid introduction of new American varieties the botany of cultivated plums has become much more complicated. Botanists have found it necessary to make new species of recently discovered forms, and as varieties of these forms have been introduced to cultivation, horticulturists have had to keep pace with botanical study in order to maintain an acquaintance with the fruits in their gardens. In the foregoing tables the different varieties are referred to their botanical parentage as accurately as could be done at this time. For the most part the dispositions made of the several varieties are those generally accepted. A few are questionable, but it was thought better, in cases of doubt, still to place the doubtful variety in the group to which it seems to belong, rather than to throw such varieties into a mixture by themselves.

When Mr. Andrew J. Downing wrote his Fruit and Fruit Trees of North America, he recognized only three species of plums as concerned in the parentage of our cultivated varieties, namely, *Prunus domestica*, the European plum; *P. Americana*, the American red or yellow plum; and *P. Chicasa*, the Chicasaw plum. Since then the classification has been so much complicated, both botanically and horticulturally, that it requires some critical attention to understand the subject. It is thought the more wise to take up here the botanical classification of plums because the limits of cross pollination and the lines of affinity among varieties may well be supposed to follow very closely the true botanical boundries of the parent species. The natural relationships of the various groups are shown in the following conspectus:

### I. CONSPECTUS OF CULTIVATED AND NATIVE PLUMS.

FAMILY ROSACEÆ; Genus PRUNUS.

FOREIGN SPECIES.

P. DOMESTICA, L. COMMON EUROPEAN PLUM. Probably originally from Asia. Flowers showy, white, more or less fascicled; leaves large, ovate or obovate, usually firm and thick in texture, very rugose, usually pubescent beneath, coarsely serrate; shoots usually downy; fruit very various, of many shapes and flavors, but mostly globular-pointed or oblong, the stone large and slightly roughened or pitted.

P. CERASIFERA, Ehrh. MYROBOLAN or CHERRY PLUM. Differs from the last in a more slender habit, often thorny; flowers mostly smaller; leaves smaller, thin, smooth and finely and closely serrate; fruit globular and cherry-like, ranging from the size of a large cherry to over an inch in diameter, with a depression about the stem, in various shades of red or yellow.

P. **TRIFLORA**, Roxb. **JAPANESE PLUM.** A strong growing tree, perhaps native to China, numerous varieties of which have recently been disseminated in the United States. Flowers usually densely fascicled; leaves and shoots smooth and hard, the former obovate or oblong-obovate, prominently pointed and finely and evenly serrate; fruit usually conspicuously pointed, red, yellow or purple, with a very firm flesh and commonly a small stone.

## NATIVE SPECIES.

### *Trees.*

P. **AMERICANA**, Marsh. **COMMON WILD PLUM.** The type distinguished by entire calyx lobes, which are pubescent on the inner surface; stone turgid; leaves oval or slightly obovate; petioles mostly without glands. Tree spreading, ragged, thorny, 8-20 ft. high; flowers large, white, on slender pedicels; leaves very coarsely veined, never glossy or shining; fruit more or less flattened upon the sides, firm and meaty, the skin tough and glaucous and never glossy, ripening through yellow to red. Occurs wild from N. J. and N. Y. to Mont. and Colo. It varies southward, in Texas and New Mexico represented mostly by the variety **MOLLIS.**

Var. **MOLLIS**, Torr. & Gray has the leaves and pedicels pubescent, especially when young.

Var. **NIGRA.** (See p. 60.) **CANADA PLUM, RED PLUM.** (P. **NIGRA**, Ait. P. **AMERICANA**, T. & G. and 6th ed. Gray's Manual.) In its extreme forms easily distinguished by the glandular-serrate calyx lobes, glabrous on the inner surface; compressed stone; broadly oblong-ovate to obovate leaves with petioles bearing two glands. Flowers large, white, with short thick peduncles conspicuously marked by the scars left by the falling of the bud scales; pedicels dark red, slender, glabrous; calyx tube broadly obconic, dark red on the outer and bright red on the inner surface; fruit oblong-oval, orange-red; stone nearly oval, compressed. Occurs wild from Newf. west to Rainy and Assiniboine Rivers in Canada, and commonly in the New England States where it is found along roadsides and in waste places.

P. **HORTULANA**, Bailey. **WILD GOOSE PLUM.** A strong, wide-spreading, small tree, with smooth, straight twigs, and a peach-like habit; flowers rather small, often very short-stalked; leaves narrow-ovate or ovate-lanceolate, thin and firm, flat, more or less peach-like, smooth and usually shining, closely and obtusely glandular-serrate; fruit spherical, bright colored and glossy, lemon yellow or brilliant red, the bloom very thin, juicy, with a clinging, turgid and roughish, small, pointed stone. Occurs wild in the Mississippi valley in the neighborhood of St. Louis.

Var. **MINERI**, Bailey. Differing more or less from the species by the dull and comparatively thick leaves which are conspicuously veiny below and irregularly closely toothed and more or less obovate in outline and by a smoother and more Americana-like stone.

Hyb. **MARIANNA.** This plum is thought to be a hybrid between the Myrobolan and the Wild Goose. (L. H. Bailey, Cornell Exp. Sta. Bull. 38, p. 32.) Perhaps one or two other varieties have a similar origin.

P. **CHICASA**, Michx. (Properly P. **ANGUSTIFOLIA**, Marsh.) **CHICKASAW PLUM.** Slender tree, 12-20 ft. high, slender, zigzaged twigs; smaller, lanceolate or oblong-lanceolate leaves which are very closely and finely serrate, shining and trough-like; fruit small, very early, red or rarely yellow, the skin thin and shining and covered with many small, light dots and a very thin bloom; the flesh soft and juicy, often stringy, closely clinging to the small, broad, roughish stone. Wild from Del. S. and W. to E. Kans. and Tex.

P. **ALLEGHANIENSIS**, Porter. **SLOE.** A small, slender tree or shrub, 3-15 ft. high; leaves lanceolate or oblong-ovate, often long-acuminate, finely and sharply serrate, softly pubescent when young; fruit dark purple, with a bloom. Alleghany mountains in Penn.

P. **SUBCORDATA**, Benth. A small tree 20-25 ft. high; leaves broadly ovate or orbicular, usually cordate, sharply and often doubly serrate, slightly coriaceous, dark green on the upper and pale on the lower surface; flowers in 2-4 flowered umbels on slender pedicels; calyx lobes oblong-obovate, rounded at the apex, half as long as the white petals; fruit oblong, dark red or purple or sometimes yellow. Pacific coast species.

P. **UMBELLATA**, Ell. **BLACK SLOE; HOG PLUM.** A small bushy tree; flowers on slender pedicels nearly an inch long, rather large, white; leaves smallish, ovate or slightly obovate or sometimes short oblong, thin and dull, closely and evenly serrate; fruit about ¾ in. in diameter, yellow or reddish; flesh firm and austere; stone short and turgid, cherry-like. Sea shore from S. C. to Fla., and westward to Miss., La. and Ark.

### *Shrubs.*

P. WATSONI, Sargent. THE SAND PLUM. A shrub 6-10 ft. high; leaves ovate, acute, rounded or wedge shaped at the base, finely crenulate, serrate, lustrous on the upper and pale on the lower surface; petioles slender, grooved, bi-glandular at the apex; flowers in crowded, few-flowered fascicles; calyx cup-shaped, the lobes acute, rounded at the apex, without glands, ciliate on the margins, pubescent on the inner face; petals inserted remotely on the glandular disk, narrowly obovate, rounded and more or less erose above, contracted below into short claws, pure white; fruit globose or rarely oblong, orange red. Sandy streams and hills S. and S. E. Neb. and Central and Western Kansas.

P. GRACILIS, Engelm. and Gray. A small shrub, 1-4 ft. high; soft pubescent; leaves oblong-lanceolate to ovate, acute, sharply serrate, becoming nearly glabrous above, 1-2 in. long; pedicels and calyx pubescent; fruit less than ½ in. in diameter; stone rather turgid, sub-orbicular. Prairies and sandy places, S. Kans. to Texas and Tenn.

P. MARITRIMA, Wang. BEACH PLUM. Low straggling shrub, 1-5 ft. high leaves ovate or oval, finely serrate, softly pubescent underneath; pedicels short pubescent; fruit globular, purple or crimson, with a bloom, ½ in. in diam.; stone very turgid, acute on one edge. Sea beaches, N. Bruns. to Va. Some distance from the coast has leaves smoother and thinner, and fruit smaller.

## 2. REMARKS UPON BOTANICAL GROUPS.

**EUROPEAN, OR DOMESTICA GROUP.** The cultivated varieties of the European plum bear the best and most salable fruit. They are generally hardy in most sections of Vermont, though most of the 1896 crop was killed by the severe winter weather. The pistils in varieties of this species are uniformly larger and stronger than in other species and are practically never defective. These varieties are usually deficient pollen bearers; but their need of cross-pollination has not yet been clearly shown, nor their best pollenizers pointed out. Pistils and anthers appear to mature at the same time, and heterostyled or bisexual forms are seldom or never found.

**MYROBOLAN.** This plum has been extensively used as a stock, but has been rapidly losing favor, the Marianna or seedlings of *Prunus Americana* being generally substituted.

**THE JAPANESE PLUMS** have not yet been long enough known in the United States to have found their final position in our estimation. They are an important and desirable acquisition. Several varieties have been planted in Vermont, and for the most part are sufficiently hardy to justify their planting. Abundance usually fruits here, bearing heavy crops. All blossoms of Japanese varieties, however, were killed by cold weather during the winter of 1895-6. They seem to be considerably weaker in their pistils than varieties of the domestica group, but this does not interfere with their fruitfulness.

**AMERICANA GROUP.** The plums of the Americana group resist cold much better than any others. They are the hardiest we have. Americana varieties now hang loaded with fruit beside the Japanese, domestica and Chicasaw varieties, which are entirely bare. They are to be especially recommended for planting in cold and exposed localities where the domestica varieties are uncertain. In general the fruit is inferior to that of the domestica varieties, although many of the best sorts are very acceptable on the table and quite salable in the market. Americana seedlings seem to make good stocks for working varieties of the domestica and other groups. Wild and cultivated forms of this group are peculiarly delicate in sexual organization, to an extent which sometimes interferes materially with the crop. Most varieties probably require cross-pollination. The blossoms themselves make provision for this by numerous contrivances, the most efficient of which are proterogyny, (see fig. 2.) the suppression of pistils, and the selective power of the pistils in receiving pollen.

The variety *mollis* of *Prunus Americana* is represented in cultivation by several horticultural forms; although the origin of the horticultural forms from the botanical variety does not seem to be necessary, but rather doubtful in some cases. The leaves and pedicels, especially in cultivated varieties, are found to be pubescent in all degrees, and it is quite possible for a distinctive degree of pubescence to appear as a garden character, although the variety might be genetically referable to the smooth type. Several varieties not usually put in this section of the Americana group are quite pubescent enough to be so classified. The southern distribution of this botanical variety might raise a question as to whether or not it is as hardy as the type when planted northward.

The variety *nigra* of *Prunus Americana* is here proposed in place of Aiton's *Prunus nigra*, and in order to satisfy the necessities of horticultural and botanical intercourse. Gray's Manual of Botany combines all these very diverse forms under one name. Professor Bailey's recent revision of Field, Forest and Garden Botany does the same, and in his paper on The Cultivated Native Plums and Cherries* Professor Bailey says, speaking of the characters used to distinguish *Prunus nigra* from *P. Americana*: "I am unable to find any constancy in these characters. * * * I am obliged, therefore, * * * to unite *Prunus nigra* with *P. Americana*. This I regret the more, because it is undoubtedly true that there are two well marked wild varieties—possibly species—passing as *P. Americana*." It is evident that we must have some way of conveniently designating such an important difference, and the application of the name *Prunus Americana*, var. *nigra*, seems to me to dispose of the case in best accord with the natural relationships on the one hand and with our acquired habits of nomenclature on the other.

The variety *nigra* is even more hardy than the species, ranging much further northward; its pistils are much stronger and more regular in their development; it bears pollen somewhat less abundantly, and whereas the species has a tendency to be proterogynous (see note p. 50) Professor Sargent characterizes the variety (which he calls *P. nigra*) as proteranderous.†

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*Cornell Exp. Sta. Bull. 38. p. 6.

†C. S. Sargent, Sylva N. A. IV. p. 15.

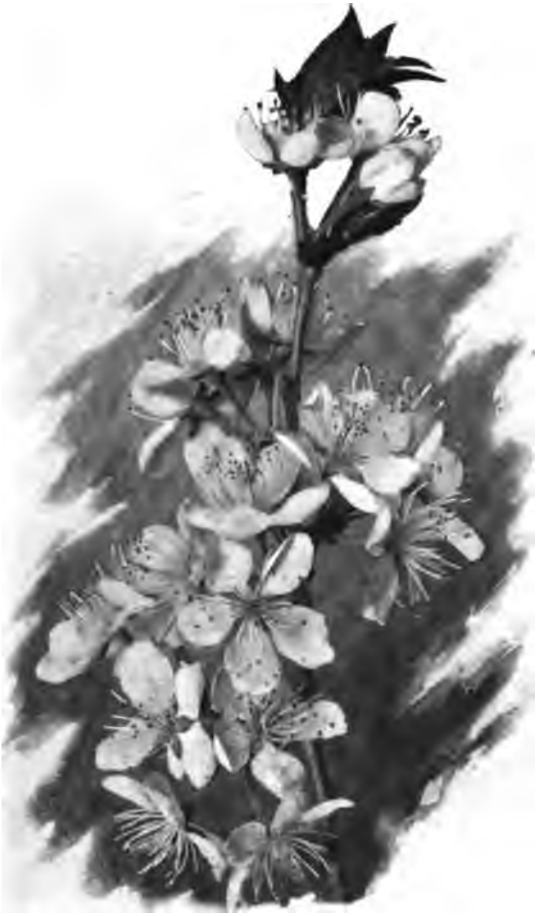

FIGURE 6. FLOWERING BRANCH OF EASTERN WILD PLUM. *Prunus Americana*, MARSHALL, VAR. *nigra*, F. A. WAUGH.

This point was not satisfactorily verified in our own examinations this spring. This is the common wild plum of Vermont and neighboring States.

WILD GOOSE GROUP. The plums of the Wild Goose group do not seem to have been generally tried in Vermont. They are usually quite as hardy as the Japanese varieties, and are well worth a trial. The Wild Goose and its most closely related varieties, are commonly said to need cross-pollination, and to be themselves weak pollen bearers. Weaver and other Americana varieties have usually been recommended as pollinizers, but it would be worth while to determine whether or not certain other varieties of *Prunus hortulana* which bear abundant pollen, are not better for this purpose.

THE MARIANNA PLUM is sexually weak to a marked degree. It is always regarded as an uncertain bearer, and large crops from it are quite exceptional. Its affinities in pollination are extremely problematical. At the present time it is most useful as a stock. It grows readily and vigorously from cuttings set in the open ground; it buds or grafts easily; the unions form readily and are apparently lasting. To a great extent it has superceded the Myrobolan as a stock. Although of Texas origin it seems to be perfectly hardy in this State.

CHICASAW—The name *Prunus Chicasa* is retained in place of *P. angustifolia*, which is technically the correct one for the Chicasaw plum, on account of its familiarity to horticulturists and botanists, and because it is used in Gray's Manual and in Field, Forest and Garden Botany. These plums form an attractive group, some of the varieties being very prolific and excellent for the table. Although some varieties are sufficiently hardy to make them desirable in Vermont plantings, they are. as a group, better adapted to warmer localities. They do not show, so far as our own study has gone, any special adaptations for cross pollination.

*Prunus Alleghaniensis* has not been introduced to cultivation, and is quite restricted in its range. *P. subcordata* is not known east of the Cascade Mountains. "In Oregon and Northern California the fruit is collected and consumed in large quantities, both fresh and dried, and is used for preserves and jellies."* It is also used as a stock for European plums. *P. umbellata* locally known as the hog plum, is known only wild. "The fruit is gathered in large quantities and is used in making jellies and jams."†

THE DWARF SAND PLUM, until recently, has been put into the Chicasaw group, which it most nearly resembles. It is, however, quite distinct; and in 1894 Professor Sargent set these peculiar forms off from *P. Chicasa* with the name *Prunus Watsoni.*[*] The points of distinction are given in the description, page 59. The wild bushes of this species bear abundant crops of superior fruit. The plums are eagerly gathered and used in preserves or jellies. Some few varieties have been propagated and introduced, as the Bluemont,[†] by Prof. E. Gale of Manhattan, Kansas, but they have thus far received only local notice. This species, as it grows wild along the Republican and Arkansas rivers in Kansas, is attractive in so many particulars that it would seem very strange did it not eventually achieve some horticultural distinction. Some experiments have been made with these plums as dwarf stocks, but no definite results have been reported.

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*C. S. Sargent, Sylva N. A. IV. p. 32.

†Ibid, page 34.

*Prunus gracilis* bears fruit rather sparsely and of small size and comparatively inferior quality. However, it is sometimes gathered, as I have known it to be in Oklahoma, and made up into jellies.

THE BEACH PLUM, *Prunus maritima*, is cultivated both as an ornamental plant and for its fruit. In the former capacity it is quite desirable; in the latter it is of little importance.

THREE OTHER SPECIES of plums, namely, *Prunus rivularis*, Scheele, *P. glandulosa*. Torr. & Gray, and *P. minutiflora*, Englm, are listed by Coulter[‡] as appearing wild in the United States ; but although the fruit of the first is said to be excellent, they are practically unknown to us.

With this wonderful array of native plums before us, many of which, though bearing excellent fruit in nature, have never been tried in cultivation, we may well believe that we have seen hardly the beginning of the cultivated plums in America.

## VI. QUOTED OPINIONS AND OBSERVATIONS.

**THOMAS MEEHAN.**—"Many trees vary in the relative strength and vigor of the sexual organs, and thus the fertility is affected. This has been especially noted in American species as compared with European allies. In the American species of plum some individuals are not unfrequently sterile. In the temperate parts of Europe dimorphism is measurably constant in its conditions. This is not the case in America. A plant proterandrous one season may be proterogynous another. This is the case with all our fruit trees, and especially those which have separate male catkins. In this section proterandry is very common in cases where the plants would in other situations be regarded as inclined to proterogyny. * * * It has been clearly demonstrated that some strawberries, infertile by themselves, are rendered fruitful by neighborship with individuals having abundant pollen, and I take it this must be true of all plants and trees."—*Private Letter*.

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[*] C. S. Sargent, Garden and Forest, 1894, p. 194.

[†] Private letter from Geo. C. Brackett, Sec'y Am. Pom. Soc.

[‡] John M. Coulter, Manual of the Phanerogams and Pteridophytes of Western Texas, pp. 102-103.

O. M. LORD.—"I have tried to keep a record for several years of the percentage of blossoms without pistils on different varieties, to see if we could establish sufficient data to prove the trees diœcious, and I am inclined to believe they are somewhat so, functionally, if not botanically. I can show groups on my own grounds standing within a few feet of each other, where one has missed fruiting but once in twenty-five years, and the other has not borne a plum, the blossoms being without pistils."—*Private Letter*.

J. W. KERR.—"I have had extended opportunities to note effects of mixed planting. With varieties of native species here, I have found none yet that are reliably self-fertile. In mixed planting varieties of nearest allied species blooming at the same time completely overcome the peculiar individualisms. Scores of cases have come under my observation where isolated varieties of natives were almost wholly unproductive. In several such instances, upon my recommendation, either a few grafts of other varieties were set into bearing trees, or other varieties were planted amongst them, completely revolutionizing matters. * * * * The absence of pistils in plum flowers is confined to certain varieties with me here, and mostly—almost wholly—to the Americanas, though in rare instances I have found "blanks" in Wild Goose. I have a hybrid between Wild Goose and Troth's Early Peach, the blossoms of which never bear pistils."—*Private Correspondence*.

L. H. BAILEY.—The chief difficulty in the growing of native plums, is the fact that some varieties do not fertilize themselves. This peculiarity appears to be due, not to any imperfection in the flowers, but to the comparative impotency of pollen upon flowers of the same variety. The impotency of pollen appears to be characteristic of certain varieties, as, for example, Wild Goose, Miner, Wazata, Minnetonka, Itasca. Other varieties of the same species are fertile with themselves, as Moreman, Newman, Mayland, Golden Beauty, Marianna, Deep Creek, Purple Yosemite. In order to insure fertilization, mixed planting is practiced, when the impotent varieties are grown; and it is an important study to determine what varieties are the best pollenizers for a given kind.—*Cornell Exp. Sta. Bull. 38*.

C. W. H. HEIDEMAN.—I know of no group of plants more favorable than the genus Prunus for the study of the order of evolution from the hermaphrodite stage to the higher stage of bi-sexuality. Their organs of reproduction present a number of peculiarities of morphology and function unusually interesting and significant."—*Minn. Hort. Soc. Rept. 1894*.

E. S. GOFF.—"Our observations indicate that the failure of plum blossoms to set fruit in our native plums is probably due to more than one cause, and while they do not show that the failure is never due to a lack of pollen, it seems probable that it more often results from a deficiency of pistils or from cold weather during the period of fertilization." *Wis. Exp. Sta. Rpt. 1894. p. 350.*

## VII.—QUERIES.

1. What causes influence from year to year the proportion of defective plum pistils in certain trees and varieties?
2. Does the number of defective pistils materially influence the amount of the crop, except in cases of total defectiveness?
3. What varieties are self-fertile, and what ones require cross-pollination?
4. What varieties have particular affinities and predelictions in pollination? and what are these affinities?
5. Does pollination take place more readily among varieties of the same botanical species?
6. Does the character of the pollen affect the character of the fruit?
7. How long do the stigmas of the several varieties remain receptive? and how long does the pollen retain its vitality?
8. Will the continued intercrossing and hybridizing of sorts in the orchard tend to produce varieties characterized by increasing sexual weakness?

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## VERMONT

# AGRICULTURAL EXPERIMENT STATION.

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## Salad Plants and Plant Salads.

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# SALAD PLANTS AND PLANT SALADS.

By F. A. Waugh.

## I. SALAD PLANTS.

### 1. General Considerations.

It seems highly desirable, in view of the difficulties which the farmer experiences in making both ends meet, that he should get just as much of his living as possible from his farm, his garden and his orchard, and as little as possible from the grocery store. It is not unjust to say that few farmers' families get as much of their daily food from their gardens as they might. It is possible on the farm to grow hundreds of fruits and vegetables which may be enjoyed by the family in a condition of freshness and perfection quite unknown to patrons of city markets. Yet many of the commonest vegetables are frequently neglected; and it is but seldom that plants are grown especially for salads. People plead that they have not time and money for such enterprises; but the requirements are not time and money, but study and forethought. If these are given, the fruit and kitchen garden may become the farmer's chief store of wealth, health and gastronomic satisfaction.

Common lettuce is the only true salad plant which has ever become popular in America. But though lettuce leaves are often eaten fresh and uncooked as in a true salad, Americans usually dress them with condiments, such as vinegar and sugar, which leave only a remote resemblance to the typical salad. It will, therefore, be better for our present purpose to take such plants as cress, corn salad and white mustard as types of the salad plants proper. In the subsequent pages the endeavor is to bring to notice several of the plants which are best for this particular purpose.

No attempt has been made at a complete catalogue of salad plants. The discussion is confined to such plants as we have actually grown on the Station grounds; the cultural methods suggested are those with which we have ourselves succeeded; and the salads described are such as we have ourselves made, eaten and enjoyed. Thus we feel that we have descended sufficiently from the bugaboo level of "theory," and are dealing with matters of practical experience.

Doubtless all vegetables ought to be fresh; but with salad plants the demand is imperative. A good salad cannot be made from wilted or stale plants. For this reason the best salads are practically prohibited to people who do not have their own gardens. The plants should be freshly picked within half an hour of meal time. Up to this time they should have been rapidly and vigorously grown. A rich spot of ground, plenty of water, clean and thorough culture with favorable weather must combine for best results. Dry, tough, wilted, weed-choked plants are not worth gathering. Yet most of the true salad plants reach edible maturity so quickly that any reasonable attention should secure good returns. *Here again it is not time and money that are required for success, but a little thoughtful promptness of action.*

### 2. SALAD PLANTS PROPER.

**Cress, or Garden Cress.***—Probably the best salad plants for general culture in this country, are Garden Cress, White Mustard and Corn Salad, in the order named. Garden Cress and Mustard are grown together in large quantities for the London market, and form the most popular English salad. According to the translator of The Vegetable Garden, some of the London gardeners use as much as five hundred pounds of seed of Garden Cress in a single season.

1. CRESS. A SALAD GROWING IN A FLOWER POT—THREE WEEKS FROM SEED.

Garden Cress may be sown in any soil, at any time of the year between severe frosts, and will give plants fit for the salad bowl within three to four weeks. From the fact that it

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*[*Lepidium sativum*, *L.*](#) There are many plants, differing greatly from each other, but all passing loosely under the name of "cress." The so-called Upland Cress is described on page 69. Water Cress. *Nasturtium officinale*, R. Br., is introduced from Europe and grows wild and cultivated along streams and in wet places. It is frequently seen in city markets, and finds ready sale. Besides these the following plants take the name of cress:

*Cardamine pratensis*, L.; Cresson des prés, Le bon Jardinier; Meadow Cress. The Vegetable Garden.
*Spilanthes oleracea*, L., Pará cress, The Vegetable Garden.
*Lepidium Chilense*, Desf., Le Potager d'un Curieux.
*Lepidium piscidium*, Forst. "
*Lepidium Virginicum*, L. "
*Senebiera pinnatifida*. DC. "
*Nasturtium indicum*, DC. "
*Gynandropsis pentaphylla*, DC. "
*Tropaeolum majus*, L., Indian Cress, Catalogue of Haage & Schmidt

runs rapidly to seed, it is best to make successional sowings at intervals of two weeks or less. During the hotter weeks of summer, better salads will result if the plants are grown in a half shady place. During the winter salads may be quickly and easily grown from cress seed sown in boxes or pots and placed in hot beds, greenhouses or sunny windows. Cress is fit for use when the leaves are three inches long, though the English are said to eat it as soon as the second leaves appear. After the seed stalk forms it is no longer at its best, but if the young leaves are carefully picked they are still quite palatable.

Garden Cress as a salad plant is characterized by a fresh, pungent, peppery, aromatic taste, much more appetizing than radishes or lettuce. It is more crisp than most salad plants. The finely dissected leaves of most varieties resemble parsley, and may be used with good effect in garnishing meat dishes.

Varieties of the species under consideration are not common among American seed merchants. In no catalogue of leading American seed houses is more than a single variety listed ; though Le bon Jardinier, 1896, published in Paris, names five varieties,[*] and a leading French seed catalogue quotes an equal number. Somewhat different names are applied to the single varieties offered by various American seedsmen, but it is evident that these variable names represent no varietal distinctions. All this is indicative of the small appreciation which the plant has hitherto met in this country. There are doubtless several strains already extant in America, from which different varieties adapted to different palates and various purposes may readily be bred as soon as the selection is made an object to the seed growers.

**Upland Cress.**[†]—This plant bears a considerable resemblance, both in form and flavor, to the better known Water Cress, (see foot note, p. 68.) It will be acceptable to many gardeners and cooks on that account. The cut (Figure 2) which is made from a photograph of a specimen grown in our garden, shows the plant at the proper stage for table use. The leaves lie flat upon the ground, and are thereby apt to be soiled by rains. The plant does not run rapidly to seed, as does the Garden Cress, but during hot weather the leaves soon become tough and bitter. The summer crops are better grown in partly shaded situations. The Upland Cress requires a longer time from planting to picking than the Garden Cress. The crop sown this year, July 28, was ready September 18, or fifty-two days after sowing. This term might doubtless be shortened by treatment proper to that end.

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[*] These five French varieties are designated respectively: *Commun, ou ordinaire* common; *frisé*, curled; *nain très frisé*, dwarf extra curled; *Cresson à larges feuilles*, large leaved cress; and *Cresson d'Australie, ou doré*, Australian or golden.

[†] *Barbarea vulgaris*, R. Br., and *Barbarea præcox*, R. Br. both pass under such names as Upland Cress, Winter Cress, Hardy Cress, American Cress, Scurvy Cress, etc., the distinctions, both horticultural and botanical, being ill-defined. Probably *Barbarea præcox* is merely a variety of *B. vulgaris ;* and each horticultural variety probably needs separate study before it can be referred to the one or the other. The stock grown by us this year represented the species *B. vulgaris.*

2. UPLAND CRESS.

The Upland Cress is to be recommended for variety's sake. It makes a very pretty and inviting salad, and doubtless would be preferred to the Garden Cress by some palates. Still with most Americans it would be a second choice.

**White Mustard.***—Next to the Garden Cress already described, White Mustard is the most quickly and easily grown and the most appetizing of salad plants. Seeds may be sown and treated exactly like those of the Garden Cress. Indeed the two are frequently sown together. We do not recommend this method, however. On our own grounds the White Mustard requires a few more days than the Cress for its perfection. It runs to seed with equal rapidity, and should be grown from several sowings, made at intervals of ten to fifteen days.

The leaves are very pungent when young, though aside from the peppery taste, they do not possess any distinct flavor, as do some other salad plants. Still they make a very appetizing salad, especially when served early in the spring, when the appetite greedily accepts anything bearing the fresh smell of the earth, even watery radishes and green onions. The seeds of the White Mustard are in common culinary use.

**Corn Salad.**†—Apparently only one variety of this species is grown in America and is known simply as Corn Salad. Under this name it may be found in any seed catalogue, though it is hardly known in American kitchen gardens. It is valuable chiefly as fur-

3. CORN SALAD.

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**Brassica alba*, Boiss.—Various other species of Mustard are mentioned in another connection, p. 74.

†*Valerianella olitoria*, Poll.—Although American catalogues merely mention Corn Salad without comment, description or subdivision, there are five varieties grown in England and France. See The Vegetable Garden, p. 203, and Le bon Jardinier, 1896, p. 552.

nishing a diversity and a succession with Mustard and Cress, although its exceedingly mild and delicate flavor would give it the preference with those to whom the taste of Cress is too pronounced. It is more insipid, less crisp, with much less self-assertiveness than Cress. It makes a good salad, either alone, or mixed with more pungent herbs, and is more especially suited to the heavy and much fortified salad dressings, such as are sold at groceries and too exclusively made in American kitchens.

Corn Salad grows more slowly than Mustard or Cress, requiring, according to our experience, about sixty days to reach proper size. We have practiced sowing it in the open garden during the Spring and summer, exactly like Radishes, Lettuce or Cress. It is said to be hardy, withstanding considerable freezes, and is therefore recommended for fall sowings. These late plantings are intended to furnish salads for late fall and early spring. These points have not yet received satisfactory verification with us.

**Various Other Salad Plants.**—It has already been said that the common lettuce is properly a salad plant. In many places it is served with oil and vinegar, or with other true salad dressings and enjoys a deserved popularity. Still, for simple salads, it is surpassed by the plants already described, and its chief advantage over them is that it is better known and more commonly cultivated. It will be quite unnecessary here to give any space to a notice of its characteristics or cultural requirements.

The varieties of Cos Lettuce constitute a class separated from the better known cabbage lettuces by the form of their heads and the shape of their leaves. They belong to the same botanical species. The Cos Lettuces have narrower, more-elongated, usually stiffer and less curly leaves, which form a taller, longer, usually more solid head. They take their name from the Island of Cos in the Grecian Archipelago, where they are said to have had their origin. For use in salads they deserve wider notice ; and are in fact gaining in popularity in this country. The best variety for general culture is the Trianon, although some newer varieties give promise of better qualities. It may be grown out of doors in the same manner as the cabbage lettuces.

Endive is frequently used uncooked in the usual style of a salad; but, according to our experience, is too bitter to be generally esteemed when served in this way. We have therefore chosen to place it among the plants suitable for cooking. (See page 73.)

Chicory is grown in large quantities in France for salads, and many improved varieties are held for sale. The wild forms are also used. However, we would recommend American gardeners and cooks to try other salad plants first.

Other plants which are more or less frequently and exclusively used for salads are common nasturtiums (Tropœolums) cabbage, (as "slaw") broccoli, cauliflower and potatoes. The last three are cooked, however, before being served in salads.

### 3. PLANTS SUITABLE FOR BOILED SALADS, OR GREENS.

Every American household is acquainted with the dish called "greens," which is more or less improvidently supplied two or three times in the spring while the appetite is ravenous for something green. This is properly a salad of boiled plants. Sometimes beets are grown for this purpose, but oftener dandelions, pigweeds and other self-sown herbs are the sole reliance. The range of vegetables from which to select for home-grown greens is very large and satisfactory. A few are worth bringing to special attention. It is worth while to grow as many of them as convenience permits, if only for the sake of the variety which they give to the bill of fare and the succession which they furnish through the season.

**Swiss Chard** has proved to be one of the most generally satisfactory plants which we have grown for greens. It is a variety (rather there are several varieties) of the common garden beet, differing from it in having large, succulent tops instead of large roots.

These tops develop rapidly after the sowing of the seed, and remain fresh and tender with remarkable persistency during the vicissitudes of the summer season. Each leaf consists of two parts practically separable, namely the mid-rib and the leaf blade. For greens the large leaf blades should be used after the removal of the heavy mid-nerves. These mid-ribs frequently attain a diameter of one by four inches, and are very sweet, crisp and tender. They are used separately, served on toast, like asparagus, or in any of several other ways. American seed catalogues ordinarily offer only a single variety; but a selection of numerous varieties may be had adapted to the several uses pointed out above.

4. SWISS CHARD.

**Spinach, or Spinage** is more commonly cultivated in gardens, forcing pits or greenhouses, for home use and for market, than any other plant of its kind. It is really the only one which is extensively forced out of season and sold for winter greens. No one can question its right to this pre-eminence. It is much more suitable for forcing than any other plant serving the same end. Its quality, when cooked, is superior. When grown out of doors,

5. SPINACH, MONSTROUS VIROFLAY— A GOOD VARIETY FOR GENERAL GARDEN CULTURE.

however, during the heat of summer, and especially when carelessly grown in unmellowed soil among weeds, it is comparatively tough, woody and worthless. As these are precisely the conditions of common farm gardening that we have had in view in our garden experiments, we have placed spinach second to Swiss chard because the latter, with us, better withstands those adverse conditions. For anyone who gives his garden sufficient care, and always for forcing, we would recommend spinach above all else.

Spinach seed may be sown in spring like radishes or lettuce, in the hot bed or open ground. The chief drawback with this practice is that it does not furnish edible greens till after the appetite for such things has been measurably appeased. A more satisfactory method of culture is that of fall sowing, in a frame or protected place. The plants get a good start in late fall, and are then covered through the winter. Early in the spring the covering is removed, and the first warm days bring on an early and appetizing dish of greens.

There are many well established varieties of spinach, presenting real diversities of character. Some are especially adapted for forcing, others for summer growing, and others for the fall and winter crop. All are good, so that it is impossible for one person to tell another what varieties to select. It is largely a matter of individual preference.

**Endive*** has already been mentioned as sometimes used uncooked for salads, but as being unacceptably bitter for such service. We have found it to make most excellent greens, however, and at certain seasons of the year, when it is in its prime, nothing can be more attractive for that pur-

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*The garden varieties of Endive are derived from *Cichorium Endiva*, L., and are thus closely related to the varieties of the common Chicory, *Cichorium Intybus*, L.

pose. The appearance of the young plants of the particular variety illustrated (the Ever White Curled) may be pretty well understood from the illustration (Figure 6) from a photograph of a young plant. The plants do not run quickly to seed, though they do not, on the other hand, retain their crispness and tenderness for a very long time. Endive is frequently blanched like celery or Cos lettuce, by tying up the leaves, drawing the soil up to the plants, and similar means. When blanched in this way, especially the white varieties give very pretty white leaves from the inside of the head. For eating cooked, however, we prefer to take the plants quite young, as shown in the illustration, and before they have had time to make heads. With ordinary outdoor culture they will lose rather than gain in tenderness between this stage and the time when satisfactory heads can be produced.

6. ENDIVE, EVER WHITE CURLED.

Endive may be sown early in cold frames or in the open ground like lettuce. Sowings may also be made at any time during the summer, although plants grown in the heat of midsummer have not the best quality. Fall grown plants may be taken up with a good supply of adhering earth and stored in a dry cellar or cold frame for winter use. From forty-five to fifty days is required to grow the crop.

There are several distinct varieties of Endive. Those with comparatively smooth leaves are the larger and coarser. The finely cut and curled varieties, and more particularly those with naturally whitened leaves, are most attractive, and usually most tender.

**Kale** is a name properly applied to several dissimilar plants of the cabbage species.* Instead of heading, however, like the cabbages, they

---

*This species, *Brassica oleracea*, of Linnæus, is really best represented by the Kales. Nevertheless, writers about garden vegetables have rather loosely divided the species into five or six subspecies, including severally, Kales, Cabbages, Broccoli, Cauliflowers, Brussells Sprouts and Kohl Rabis.

NOTE.—There are several different weeds widely distributed in Vermont and passing indiscriminately under the name of Kale. They are, however, considerably different from the cultivated Kale, being more properly mustards. They are mostly included under the species *Brassica nigra*, Koch; *Brassica Sinapistrum*, Boiss; and *Brassica campestris*, L.; though other weeds are also sometimes called Kale. It is proper to note here that young plants of almost any of these weeds may be cooked as greens with fair to excellent results. It may be a relief to some Vermont farmers to find that wild "Kale" is ever good for anything.

produce a great abundance of large succulent leaves, which, under certain circumstances, are very good cooked as greens, or in similar ways. The rapidity and luxuriance of their growth is very striking, so that, for an equal space of ground, one could hardly grow a greater quantity of herbage. Even in our short summer here at Burlington we have grown plants in the open garden rows to the height of a man's head. Certain varieties are also decidedly ornamental, particularly those with curly and variegated foliage. Some varieties of Kale are very hardy, being able to stand severe frosts and so begin growth anew early in spring, thus furnishing the desideratum of spring greens. A little winter protection will bring the hardy varieties through even a severe winter. They are not delicate plants to handle. The leaves are better for cooking after being exposed to frost, and need not be gathered for table before. Several varieties were tested at the Vermont Experiment Station this year, every one of which succeeded admirably. The curled varieties are, however, most attractive, and apparently best adapted to table use.

7. TALL CURLY KALE—PHOTOGRAPHED FROM A PLANT FOUR FEET HIGH.

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NOTE.—Lest anyone should think that special effort has been made to array under the heading of Salad Plants, everything which could take the name, we beg leave to call attention to the following partial list of additional plants mentioned in modern garden literature and recommended for salads:

Globe Artichoke. *Cynara Scolymus*, L.
Chinese Artichoke, *Stachys Sieboldi*, Miq. (*S. affinis* or *S. tuberifera.*)
Buck's-horn Plantain, *Plantago Coronopus*, L.
Chinese Cabbage, *Brassica Pe-Tsai*, Bailey.
Chinese Cabbage, *Brassica Chinensis*, L.
Chinese Mustard, *Brassica juncea.*
Tuberous Rooted Chinese Mustard, *Brassica napiformis.*
Chinese Amaranth, *Amarantus*, *spp.*
California Peppergrass, *Brassica Japonica*, Siebold.

**Cardoon**, *Cynara Cardunculus*, L.
**Chervil**, *Anthriscus cerefolium*, L.
**Chives**, *Allium Schoenoprasum*, L.
**Italian Corn Salad**, *Valierianella eriocarpa*, Desv. (cf. p. 70.)
**Dandelion**, *Taraxicum officinale*, Weber.
**Various Cresses.** See page 68.
**Good King Henry**, *Chenopodium Bonus-Henricus*, L.
**Quinoa**, *Chenopodium Quinoa*, Willd.
**Dock**, *Rumex*, Several species.
**Malabar Nightshade**, *Basella alba*, L. and *Basella rubra*, L.
**Nasturtium**, Several species.
**Orache**, *Atriplex hortensis*, L.
**Parsley**, *Opium Petroselinum*, L.
**Rocket Salad**, *Brassica erica*, L.
**Turkish Rocket**, *Bunias orientalis*, L
**Salad-Burnet**, *Porterium sanguisorba*, L.
**Spring Beauty**, *Claytonia perfoliata*, Donn.
**Ice Plant**, *Mesembryanthemum crystallinum*, L.
**Various Sorrels**, *Oxalis crenata*, Jacq.. *O. tetraphylla*, Cav., etc.
**Pokeweed**, *Phytolacca decandra*, L.

This list includes no "salad herbs"—plants used merely for seasoning salads.

## II. PLANT SALADS.

8. READY TO SERVE.

**Salad Making.**—The simplest, and usually the best salads, consist of the very fresh leaves of some single variety of herbage, dressed with a pinch of salt and pepper dissolved in a very small quantity of salad oil and vinegar.

Thus, to make a typical salad one might proceed as follows: Select a sufficient quantity of fresh, crisp, clean leaves of cress. If it is necessary to wash them they should be dried as much and as quickly as possible by folding in a towel or some similar means which will not wilt the leaves. The leaves may be torn or cut up to convenient fineness or may be placed whole in the salad bowl, which should be deep and roomy. Then put some salt and pepper into a spoon (a teaspoon will be large enough for a salad for two persons) and fill the spoon with vinegar. Stir the salt till it dissolves as much as possible and then pour the spoonful over the leaves in the bowl. With a fork turn the leaves several times till all have become somewhat dampened with the vinegar. Then measure out a spoonful of oil, pour it upon the leaves and turn as before until the oil is thoroughly distributed over each leaf. This will require but a moment. Very small quantities of vinegar and oil are needed. It is a common mistake to use too much.

Two or more vegetables or herbs may be combined in a single salad. We have already spoken of the mustard and cress combination used in England, which is the simplest possible, and one of the best. Cress and corn salad, or cress and lettuce and many similar mixtures may be arranged as taste and convenience suggest. As an example of the more complex essays the following combination has been found highly satisfactory: Corn salad, white mustard, finely shaved brussels sprouts, a bit of parsley, chopped celery, and some thinly sliced, uncooked beet root. In making a salad of this sort, such ingredients as the mustard and the corn salad should predominate. They really form the basis, while the other ingredients are pleasant seasonings. All this means simply that any one with good taste and some ingenuity may make salads of almost any fresh and tender herbage which falls into his hands. Indeed the roadside weeds will sometimes yield a more appetizing dish than can be bought in the city markets, where wilted vegetables and high prices seem to have formed an inseparable union.

In speaking of the various green things which may participate in the salad, the old fashioned garden herbs should not be forgotten. Such things as sweet basil, mint, anise, lavender, caraway, tarragon and many others may be used in small quantities to give many delicate shades of flavor and aroma to salads. To use them, take a small pinch of the selected herbs and cut them up finely over the top just before applying the dressing.

**Salad Dressings**.—Oil and vinegar have been pointed out as the characteristic dressings for salads. Sugar and vinegar, with which lettuce is habitually overloaded, do not constitute a salad dressing; nor do several leaves of lettuce afloat in such a mixture make a salad. The combination of oil and vinegar with salt and pepper, as already described, makes the "French dressing" which is in good taste everywhere and which has a wider range of usefulness than any other. It does not please everyone at first taste; but one learns to like it after a few trials. After a little practice cream may be used in lieu of oil. That from a separator is best.

The salad dressing most commonly used in this country and the one easiest of its kind to make, is known simply as cooked salad dressing, and is made as follows: To each yolk of egg use one tablespoon of vinegar. Heat the vinegar to the boiling point, stir in the well beaten yolks of eggs and cook until thick, stirring constantly. Season highly with salt, pepper and mustard. This may be put away in earthen-ware or glass and kept in a cool place for a long while. When ready to use, thin with cream or rich milk until it is about the consistency of custard, and use like any other salad dressing.

Besides the simple French and cooked dressings described above there are many others, such as mayonnaise, for which complete directions may be found in any cook book. Salad dressings may also be bought at all grocers; but, though some of them are very good, they are not to be recommended without qualification.

**Salads of Cooked Vegetables.**—Many fine salads may be made of cooked vegetables, such as potatoes, string beans, lima beans, peas, cauliflower, broccoli, cabbage, carrots, beet roots, artichokes, etc., etc. These vegetables should be cooked separately in salted water, plunged in cold water and thoroughly drained before placing in the salad bowl. Recipes of this class are to be found everywhere.

Few suggestions are necessary with respect to the democratic American dish known as greens. This is really a salad of cooked vegetables. Some detailed consideration has already been given (See page 72) to the vegetables which may be selected for greens. The best suggestion that can be made for their preparation is to have them oftener. This will be easy enough if the garden furnishes a succession and a variety of materials. The next suggestion is that a dish of greens should be thoroughly drained.

A sloppy, soggy dish of greens is an abomination. When such delicate vegetables as endive, spinach or white mustard are cooked for greens, especially if the quantity be small, they are best served on toast with plenty of butter. The toast is useful in absorbing the extra moisture from the greens, which should be just enough to render the toast soft enough for easy mastication.

*Once more it needs to be said that at every step of the work,—growing the plants and preparing the salad,—it is not time and money and expensive apparatus which is required, but only a bit of intelligent enthusiasm in a good cause.*

1896.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 55.

DECEMBER, 1896.

# Apple Growing in Grand Isle County.

I. SUMMARY.—Page 83.
II. PRELIMINARY STATEMENT.—Page 85.
III. STATISTICS OF THE CROP OF 1896.—Page 86.
IV. METHODS IN VOGUE.—Pages 86-95.

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# APPLE GROWING IN GRAND ISLE COUNTY.

### By F. A. Waugh.

## I. SUMMARY.

**II. Grand Isle County, Vermont, is increasingly devoted to commercial apple growing. The success already achieved encourages further extension of the industry. The methods adopted have had the proof of experience, and are presumably worth adoption in other parts of the State. (Page 85 )**

**III. The crop of 1896 has been larger than in any previous one. Careful computation shows it to be 40,424 barrels of marketable apples. The number of bearing trees is 34,885; and of trees still too young to bear, 17,229. (Page 86.)**

**IV. Sandy or gravelly soils are preferred, without much reference to slope. (Page 86 )**

**Budded nursery stock, two to three years old is chosen for planting, though some prefer setting native or hardy stock and making a top by grafting. (Page 87.)**

**All commercial orchards are systematically cultivated. (Page 87.)**

**Barnyard manure is used in orchards with and without fertilizers containing more phosphoric acid and potash. (Page 87.)**

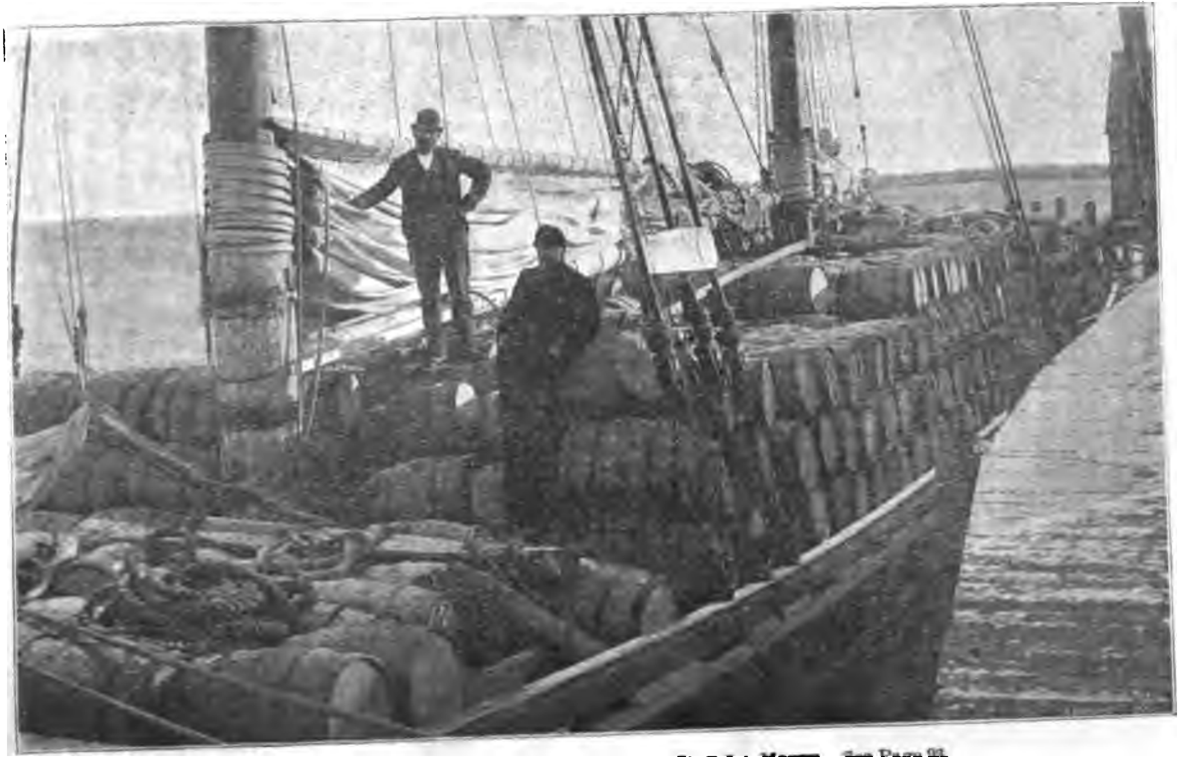
**Windbreaks are found valuable. Various methods of securing protection from winds are in vogue. (Page 88.)**

**Spraying is an accepted practice; apparatus and methods vary. (Page 89.)**

**Top grafting is easily done in spring, and is frequently practiced. (Page 90.)**

**Favorite varieties are Northern Spy, Rhode Island Greening, Baldwin, Fameuse, Talman's Sweet, Pound Sweet, Golden Russet, Ben Davis, Yellow Belleflower and Arctic. (Page 91.)**

**Apples are picked directly into barrels and are usually sent to market early. Some are held in storage. On the whole, paying prices are realized. (Page 91.)**



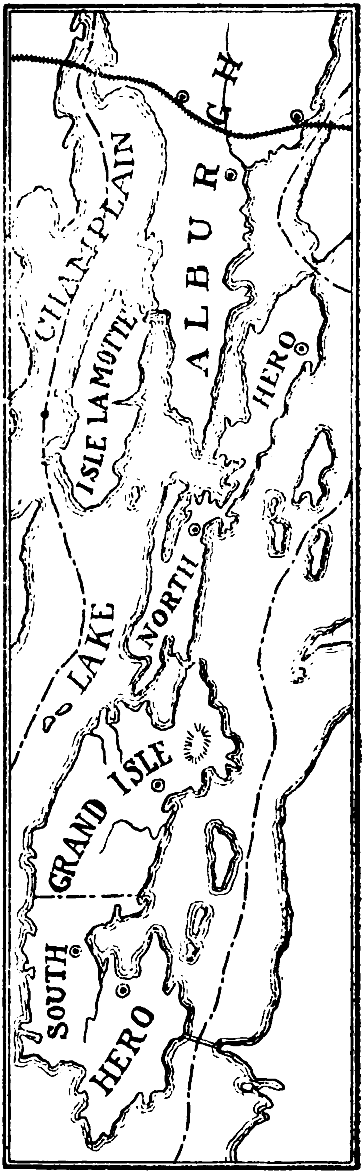
1. APPLES GOING TO MARKET BY BOAT FROM ISLE LA MOTTE. See Page [illegible].

## II. PRELIMINARY STATEMENT.

It will be news to many persons, inside as well as outside the State, to learn that apple growing has developed in Vermont to the dignity of an important commercial industry,—that in certain sections, in fact, it is the distinctive feature of local enterprise. This development has been comparatively recent, so that even those in closest touch with it have hardly yet felt the full significance of the change or have dared to look forward to future possibilities. Even the men most deeply engaged in commercial apple growing are still in the experimental stage of the business, and do not rest their practice upon years of experience or generations of prejudice.

In this condition it has been thought worth while to collect as much as possible from the nebulous mass of current information, and to reduce it to permanent form as the record of a beginning from which we hope yet to see much worthy progress. It is of great importance also that the experience already gained be made available for all who may wish to go further into apple growing and that it be firmly apprehended by them.

That part of Vermont in which the commercial production of apples has received most attention is unquestionably Grand Isle county. That county was therefore chosen as furnishing the best opportunity for a study of facts and methods which should be applicable in some degree to all sections of the State where commercial apple growing is practicable.



2. Map of Grand Isle County.

Grand Isle county is located in the extreme northwest corner of Vermont, touching Canada on the north and being separated from New York by the narrowing channel of Lake Champlain. It consists practically of three islands, (Isle LaMotte, "North Island" and "South Island") and one peninsula (Alburgh.) It is the smallest county in the State, comprising but about 50,000 acres altogether, but has a large proportion of land in farms, i.e. 47,250 acres, (Census of 1890.) The insular character of the county, it being almost surrounded by the waters of Lake Champlain, makes it naturally a very favorable district for fruit growing. The comparatively level surface, with uniform deposits of good soil contribute to the same end. Geologically the territory belongs principally to the Chazy, Trenton and Utica limestone formations with lesser outcroppings of Black River and Calciferous rocks,—strata which themselves yield valuable agricultural soils; though the surface soil over most of the county is probably deposited from other sources.

## III. STATISTICS OF THE CROP OF 1896.

Commercial apple growing in Grand Isle county has been brought into greater notice than ever before by the large crop of 1896. In order to offer some basis for a just estimate of the industry, the Vermont Experiment Station has undertaken to make a careful measurement of this crop. A very thorough investigation was made, reaching personally to each farmer and apple grower in the county, and being checked by records of nearly all shipments from the county. The statistical information secured is condensed in the following table.

STATISTICS OF APPLE CROP OF 1896.

| TOWN. | Number of Growers Reported. | Bearing Trees. | Trees too Young to Bear. | Crop of 1896. Barrels. |
|---|---|---|---|---|
| Alburgh | 14 | 710 | 820 | 1,030 |
| Isle La Motte | 45 | 11,007 | 5,550 | 14.687 |
| North Hero | 30 | 1,607 | 2,549 | 2,849 |
| Grand Isle | 60 | 12,769 | 5,460 | 12,576 |
| South Hero | 43 | 8,792 | 3,850 | 9,782 |
| Grand Isle County | 192 | 34,885 | 17,229 | 40,424 |

## IV. METHODS IN VOGUE.

### CONSIDERATIONS OF SOIL AND LOCATION.

Grand Isle county contains a small amount of swamp land and a smaller amount of land too rocky for good cultivation. Making exception of this, practically all of the county would be available for apple growing. The more gravelly and sandy tracts, underlaid with shell and limestone, are regarded as specially favorable.

All parts of the county are close enough to the Lake to feel its influence, so that this does not need to be considered. But in this and other parts of the State proximity to the Lake is a constant desideratum in the location of an orchard. In some parts of the county, particularly on the exposed shores, the land is so severely subject to the bleak winter winds as to make the situation very trying on apple trees. In fact only the hardiest varieties will grow in such spots without special protection, as discussed under "Windbreaks," page 88. Considerations of slope,—east, south, or west,—are seldom raised.

### STOCK FOR ORCHARD PLANTING.

For planting a new orchard most Grand Isle growers prefer budded nursery stock, two or three years old. For exposed situations native stock top grafted is thought to make more hardy trees. One apple grower plants all Talman's Sweets and subsequently grafts the tops with any other varieties desired. This is much better practice than the use of "natural" seedlings, first because it gives a highly desirable uniformity of growth in the resulting orchard; and, second, because the tree of Talman's Sweet is one of the very best for topworking, making a clean body with strong crotches. In buying nursery stock there is a common prejudice in favor of that which is locally grown; though, in practice, most of the stock is bought from western New York nurseries on account of price. *First-class budded trees, of standard varieties, two years old, cost $12.50 to $18 a hundred.* Some people pay more; but that is their privilege! In setting an orchard, trees should never be set closer than forty feet apart, which requires twenty-seven trees to the acre.

### CULTIVATION.

*Every commercial orchard in Grand Isle county is under cultivation.* Young orchards are planted to corn, beans or similar crops, requiring summer culture. Bearing orchards are plowed shallow late in fall, or early in spring, or both. The spring cultivation should be thorough, the harrow following the plow, and a second plowing and harrowing, crossing the first, being made within two to four weeks. Some "cover crop" is then sown to keep the ground shaded and to prevent the growth of noxious weeds. Buckwheat has been most used thus far. Before picking time this may be cut and raked toward the trees. It then serves to catch falling apples.

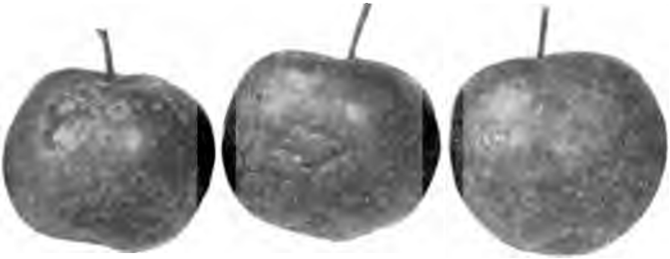
### FEEDING THE TREES.

Orchards in Grand Isle county are usually fed with barnyard manure. Some orchards receive an annual dressing, but most of them are treated biennially. One very fine orchard has been systematically treated with acid phosphate and potash, the latter being given in the form of wood ashes. Another grower of high standing uses bone meal and kainit in addition to barnyard manure. The amount of instructive experience on this subject is still small. It seems safe, on theoretical grounds, to recommend a more general use of phosphoric acid and potash in addition to barnyard manure. The Experiment Station has undertaken experiments in this line in Grand Isle county, but they have not yet progressed far enough to give any results.

### PROTECTION FROM WINDS.

A few orchards, in specially bleak situations, need protection from winter winds, but all orchards need windbreaks toward picking time. The damage done in exposed orchards by the blowing off of fruit before it is reached by the pickers may amount to fifty per cent. of the entire value of the crop, or even more. Belts of natural timber furnish most protection; but they are apt to be the breeding grounds of noxious insects. A thick row of arbor vitæ (white cedar), like that shown in Figure 3, is easily grown and furnishes ample protection. This occupies some land, however; and such dense belts of evergreens interfere seriously with atmospheric drainage, (the rapid evening flow of cold air off the land to lower ground.) This is a most important consideration. Very satisfactory results have been secured in young orchards by planting between tree rows and in encircling belts with tall-growing, western dent corn. It is practicable in some cases to plant Northern Spies on the more exposed sides of the orchard. This variety makes large trees which protect the remainder of the planting, while the fruit holds on much better than in other varieties and is comparatively undamaged by the wind.

3. WIND BREAK OF ARBOR VITÆ—PLANTED AT THE TIME THE ORCHARD WAS SET.



4. FAMEUSE APPLES SHOWING SCAB. THIS ORCHARD WAS NOT SPRAYED THIS YEAR, BUT IT WILL BE NEXT!

### SPRAYING.

Spraying is a settled practice in Grand Isle orchard economy. Not all apple growers spray; but the most successful ones spray with conscientious thoroughness. The program adopted is about as follows:

First Spraying—Early spring before the buds start—Bordeaux mixture.

Second Spraying—Just before blossoms open—Bordeaux mixture and Paris green.

Third Spraying—Just after blossoms fall—Bordeaux mixture and Paris green.

Fourth Spraying—Before the young apples turn down—Bordeaux mixture and Paris green.

Various formulas for Bordeaux mixture are in use. The Experiment Station, after several years' work on this subject, recommends six pounds of copper sulphate and four pounds of lime to a barrel of water.* As the result of careful study it appears that the methods of preparing the mixture exert a very important influence on its composition and effectiveness. The copper sulphate may be most readily dissolved by hanging it in a sack so that it just touches the top of the water. The lime should be freshly slaked just before using. *The copper sulphate and the lime should be diluted rather slowly separately, each with one half the water to be used, and the copper sulphate should always be poured into the lime and never the lime into the copper sulphate.*

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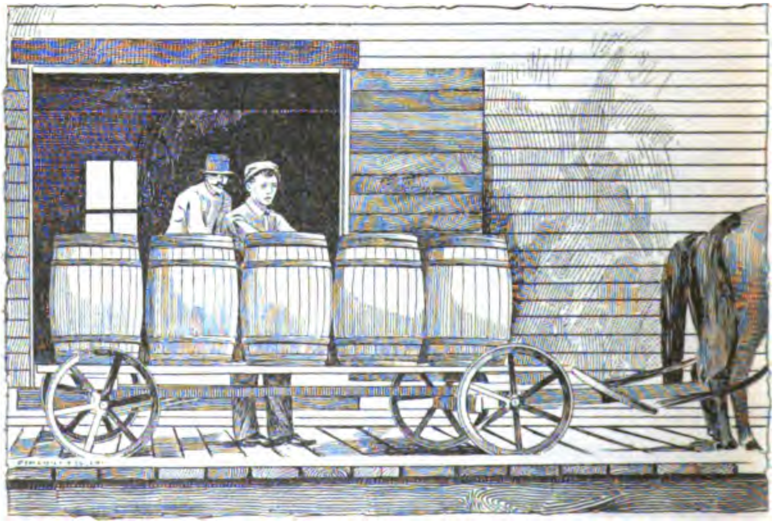
*The best strength for the solution depends largely on the kind of nozzle used and the amount of water actually put on each tree, i. e., with a nozzle throwing a coarse spray a weaker solution is desirable, some orchardists diluting the mixture to about one-half the above strength.

For more complete discussions of this subject, see Bulletin 44; Eighth Annual Report (1894) pp. 109-113; Ninth Annual Report (1895) p. 88 and p. 103. This work has been done by Professor L. R. Jones, Botanist of the Station.

A spraying outfit for an orchard consists of a tank or large barrel on wheels, a force pump, and one or more pieces of hose with nozzles. Each orchardist may secure these separate articles wheresoever he choses, and trust his own ingenuity to get them together in working order. There are no secrets to learn. There is no patented and complicated machinery to buy and keep in repair. A spraying machine is essentially a home-made affair. Each beginner must contrive and experiment somewhat for himself; but if he consults the Experiment Station or neighbors who have sprayed he need have no serious difficulty.



5. CONVENIENT LOW WAGON FOR HANDLING APPLES; HOME MADE FROM TRUCKS OF A HORSE POWER. T. L. KINNEY.

### CHANGING TOPS—TOP GRAFTING.

The case has already been mentioned (page 87) of a grower who recommends planting Talman's Sweets and later working these over by top grafting with any desired variety. The practice has much to recommend it. But in many other circumstances it becomes desirable to change the tops of certain trees. A tree may just as well be yielding the best varieties as the second best. Trees bearing "natural fruit"—seedlings—should always be top grafted to standard varieties. This work is done early in the spring, before the buds start. There is nothing difficult about it, but one who has not had experience should seek special instruction before beginning. If one selects his own scions he should always take well ripened wood, avoiding water sprouts, from trees of individual excellence. There are differences in productiveness and beauty of fruit among different trees of the same variety, and these differences are reproduced through the scions.] It is just as easy to graft from a McIntosh bearing large crops of bright red apples as from one yielding scanty crops of green and striped fruit.

### FAVORITE VARIETIES.

A great many varieties of apples are grown in Grand Isle county—too many. A Boston buyer who had bought on the islands one season was asked the next fall if he intended to come back. "No, indeed," he replied. "When a man buys a thousand barrels of apples on Grand Isle he has a thousand varieties on his hands!" One of our correspondents proudly wrote that "by next year he would have about all the varieties in bearing." *The fewer the varieties grown, within very narrow limits, in an orchard or in a neighborhood, the more advantageously are they sold.* This is one of the easiest lines of improvement open to apple growers now. By consultation and co-operation they may decide on a few standard varieties which shall be made hereafter to yield the bulk of the commercial crop. Those varieties mostly grown at present are Northern Spy, Rhode Island Greening, Baldwin, Fameuse (Snow), Talman's Sweet, Pound Sweet, Golden Russet, King of Tompkins County, Ben Davis, Yellow Belleflower. The Arctic is a new variety of considerable promise now just beginning to bear in some Isle LaMotte orchards, and being extensively planted. The young trees are upright, strong growers; the fruit is fair sized, a good, marketable red, firm, keeping well, flesh a little yellowish, mealy and of good quality. It seems that King and perhaps some other varieties have been substituted for the Arctic in many places, so that the authenticity of the variety is frequently in doubt. The Experiment Station has taken this side of the question under special consideration, and hopes to report more fully in another publication.

6. APPLE PICKING BASKET PADDED TO PREVENT BRUISING THE FRUIT.

### PICKING, STORING AND MARKETING.

Apples from Northern Vermont are exceptionally good keepers, but an apple, to keep, must be carefully handled. The usual practice in this section is to hand-pick all winter fruit into baskets which are emptied immediately into barrels, sometimes being sorted first, sometimes afterward. A considerable proportion of the Grand Isle crop is sold from the orchard. Another portion is temporarily stored to be sold "before the Lake freezes." Mr. T. L. Kinney, of South Hero, has had most experience in holding fruit in his own storage. A good idea of his house may be gained from the accompanying illustrations. In the construction of this house the following bill of lumber was used :

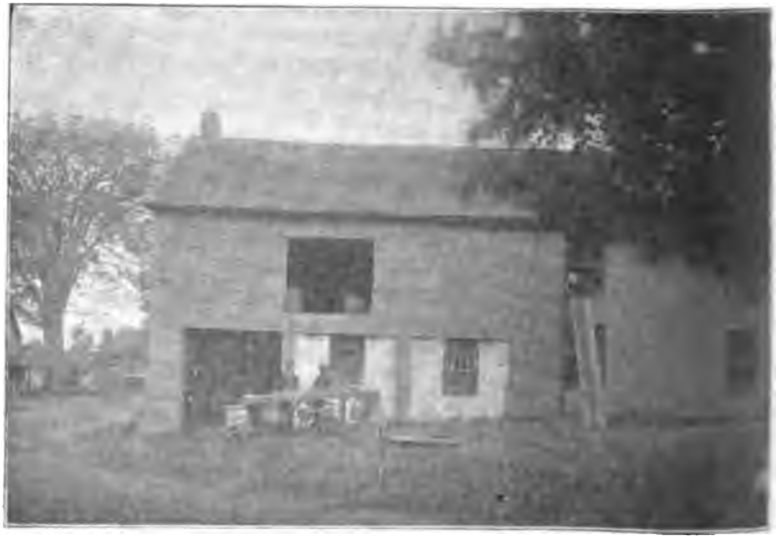
### BILL OF LUMBER FOR APPLE HOUSE.

| | | |
|---|---|---|
| 3500 | feet | wall boarding. |
| 3000 | " | roof boarding. |
| 3500 | " | ceiling (inside). |
| 7200 | " | floor boards (double floors). |
| 4000 | " | clapboards. |
| 25 | bundles | lath. |
| 22½ | squares | slate. |

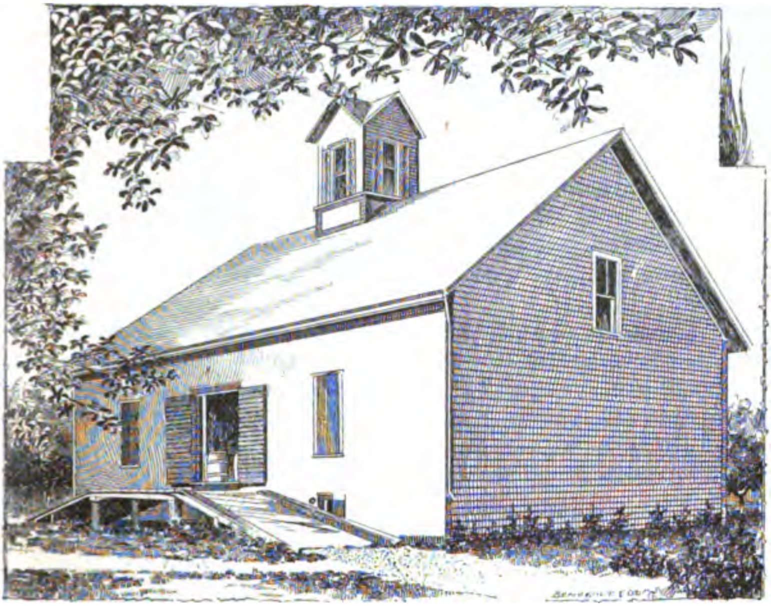
#### OUTSIDE FINISH.

| | | | |
|---|---|---|---|
| 200 | feet | 5 in. crown mould. | Lineal measure. |
| 190 | " | 3 in. bed mould. | |
| 300 | " | ⅞x10 mould for frieze and facia. | |
| 200 | " | ⅞x 7 base and water tables. | |
| 200 | " | ⅞x12 planers. | |

| | | | | | |
|---|---|---|---|---|---|
| 4 | pieces | ⅞x5 | 15 | feet, | Corner boards. |
| 4 | " | ⅞x6 | 15 | " | |
| 8 | " | 2x8 | 15 | " | Sills. |
| 16 | " | 2x8 | 13 | " | |
| 56 | " | 2x9 | 15½ | " | Floor joists. |
| 28 | " | 2x9 | 30 | " | |
| 28 | " | 1½x9 | 19 | " | Collar ties to rafters. |
| 100 | " | 3x4 | 14 | " | Wall studs. |
| 20 | " | 3x4 | 12 | " | |
| 56 | " | 2x8 | 21 | " | Rafters. |
| 26 | " | 2x6 | 10 | " | Braces. |
| 26 | " | 1x6 | 8 | " | |
| 16 | " | 1x4 | 13 | " | Ribbons. |
| 4 | " | 2x12 | 13 | " | Ridge poles. |



7. FRUIT HOUSE AND SORTING TABLE OF MR. H. H. HILL, ISLE LA MOTTE.

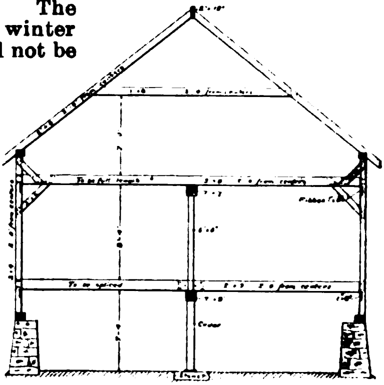


8. APPLE STORAGE HOUSE OF MR. T. L. KINNEY, SOUTH HERO.

Responsible lumber dealers in Burlington estimate this bill at $448.00. The house in question cost $1,500 finished. Mr. Kinney gives his experience in storing fruit in the following words:

"We have stored our late keeping varieties for several years and it has always proved successful. They need to be well grown, free from fungus diseases and from insect injuries, and carefully handled. They should always be partially sorted. The market calls for standard Vermont winter stock in the winter, and it should not be crowded on to the market at any other season. It is cheaper storing fruit at home than in the large cities; it is better for the fruit not to be transported long distances until it is to be used; and the orchardist also has the advantage of having the fruit under his own control."

A large part of the Grand Isle apple crop leaves the county by boat before Lake Champlain begins to freeze. Much of this fruit is unloaded at Burlington, Plattsburgh, N. Y., and other points; but frequently it is put on canal boats which go through



9. CROSS SECTION OF MR. KINNEY'S APPLE HOUSE.

the Champlain canal and the Hudson river to New York where it is delivered directly to wholesale or retail dealers. This latter method has proved very successful with some shippers. Fruit which is kept late on the islands is hauled across the ice in mid-winter to Burlington, or Plattsburgh, N. Y., and shipped by rail.

New York, Boston and Philadelphia markets get most of the crop; and it is an important matter of experience to determine which markets are best for given varieties. Thus Mr. Arthur H. Hill, of Isle La Motte, says: "Belleflower will sell well in Philadelphia, but would not pay freight if shipped to New York. Talman's Sweet sells well in Boston, but not in New York."

*Does it pay?* Emphatically, yes! Apple growing as a special industry under the conditions which obtain in the region under consideration, pays well. No business will succeed for every man; and there are discouragements in apple growing as in everything else. But here are some figures giving results actually attained. An extensive grower gives the following extracts from his cash book:

IN ACCOUNT WITH TWENTY ACRES ORCHARD, 1896.

| | | |
|---|---|---|
| **CR.** | | |
| 1000 bbls. No. 1 Apples @$1.50 | | $1,500 00 |
| **DR.** | | |
| Pruning | $ 50 00 | |
| Plowing | 18 00 | |
| Harrowing | 36 00 | |
| Picking and packing | 250 00 | |
| Barrels @30c | 300 00 | |
| Fertilizers | 50 00 | |
| Spraying | 40 00 | |
| Interest on land, $50 an acre @ 6 per cent | 60 00 | |
| | $804 00 | |
| *Net profit @ $34.80 per acre* | 696 00 | |
| | $1,500 00 | $1,500 00 |

Mr. N. G. Hill, of Isle La Motte in one year, from one tree of Rhode Island Greening, picked fourteen barrels of apples which sold for $3 a barrel,—$52. In 1889 one grower sold 222 barrels at a net total of $875. One young orchard containing 300 trees of Fameuse yielded 700 barrels in 1895 which sold at an average net price of $1.90 a barrel; or a net return of $1330, or over $440 an acre. The same orchard in 1896 yielded over 1000 barrels, bringing an average net price of $1 a barrel. These results are not extremes; *but they were secured by men who take care of their orchards!*

*May the business be safely extended?* Yes. If twenty times as many apples were grown in Grand Isle county the whole amount could be sold to better advantage than is the present output. Buyers seldom come to the orchards now; but the more apples are grown in any neighborhood the more buyers there are, the crop is handled to better advantage, and sales are easier at better prices. There is no danger of overdoing the business: for, though the market is glutted every year with poor fruit, good apples, properly handled, may be always sold at a profit.

### WHAT WE WOULD LIKE TO KNOW.

1. How to combat the railroad worm.
2. More about the details of spraying.
3. What fertilizers are best adapted to apples on our soils, and in what quantities they should be employed.
4. What cover crops are best.
5. How long an apple orchard will last, and how best to renew an old one.
6. How to take better advantage of the markets.
7. How better co-operation among apple growers may be secured.

1897.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

# BULLETIN No. 56.

FEBRUARY, 1897.

## Orange Hawkweed or "Paint-Brush."

I. Summary.—Page 3.
II. Names, Relationship and Description.—Pages 5-6.
III. Origin, Distribution and Favoring Conditions.—Pages 6-9.
IV. Damage Done and Mode of Spreading.—Pages 9-10.
V. Means of Eradication.—Pages 10-14.
VI. Conclusion and Queries.—Pages 14-15.

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FREE PRESS ASSOCIATION,
PRINTERS AND BINDERS,
1897.

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Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 56.

# THE ORANGE HAWKWEED OR "PAINT-BRUSH."

By L. R. Jones and W. A. Orton.

## I. SUMMARY.

**II. The orange hawkweed or "paint brush" is the worst weed known in certain portions of Vermont and threatens to invade other parts of the State unless precautions are taken.**

**It is easily recognized by its peculiar hairy leaves and stem, and especially by its conspicuous orange-red blossoms. (Pages 5-6.)**

**III. It is a native of the mountainous regions of Europe and has been introduced into this country as a garden flower. It appears to have become well established in this State within twenty-five years and has spread most actively within fifteen years. It is most troublesome in the northwestern counties.**

**It seems capable of rapid adaptation to varying conditions and thrives almost equally well in all soils from sandy loam to heavy clay, and at all altitudes. Its further spread may therefore be expected. (Pages 6-9.)**

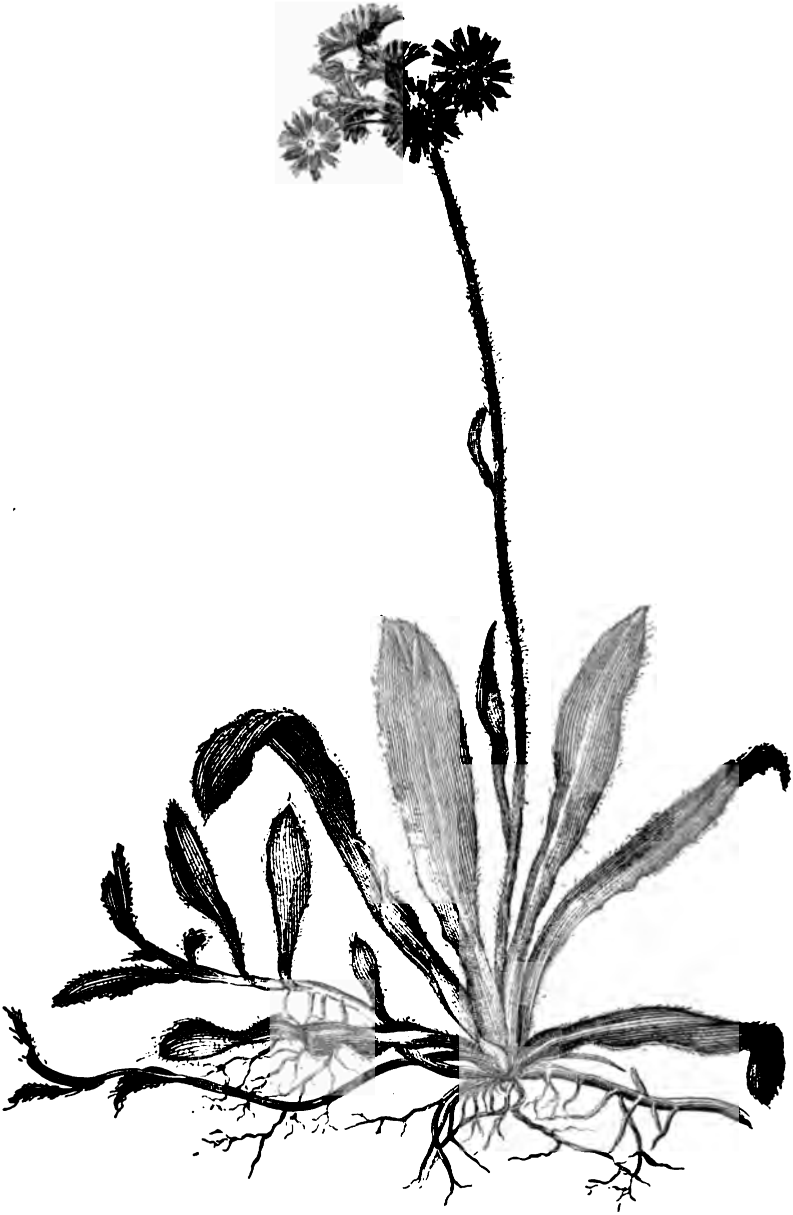
**IV. It is most troublesome in permanent grass lands, such as lawns, roadsides and hill pastures. When thoroughly established in the latter it is extremely difficult to eradicate it.**

**It is a perennial and propagates itself rapidly both by runners and by seeds. (Pages 9-10.)**

**V. This weed may be subdued by clean culture where this is practicable.**

**It is also very quickly killed by salt, which should be applied dry, scattered broadcast so as to reach the leaves of all plants, at the rate of eighteen pounds per square rod or a ton and a half per acre. This amount of salt has proved beneficial to grass, nearly doubling its yield. Salt suitable for the purpose costs from $3.00 to $5.50 per ton. It is urged that salt be used to kill the weed in all cases where only a small amount of it occurs, since the quick and complete destruction of the weed in such cases is of the utmost importance in the prevention of its wider spread. (Pages 10-14.)**

**VI. Information is desired from those having experience with this weed and correspondence is invited concerning other weed plants. )Pages 14-15.)**



1. The Orange Hawkweed or "Paint-Brush."

Entire plant in flower, one-half natural size. This plant originated from the runner shown at the lower right-hand corner. The two young runners at the left have already taken root and will soon give rise in turn to new plants.

## II. NAMES, RELATIONSHIP AND DESCRIPTION.

*Introductory.*—A partial canvass of the State with reference to weed plants made in 1891 showed quack-grass to rank as the worst weed in the popular opinion, with the white daisy second, kale third, and the "paint-brush" or orange hawkweed fourth. The last named weed has continued its spread rapidly since that time and a careful study of the plant made during the past season justifies the conclusion that it now stands unequalled as a dangerous weed in some sections of Vermont as shown *by its rapid spread, utter uselessness and thorough monopoly of the soil.*

In many sections of the State it is as yet unknown, and it is hoped that the figures and descriptions in this bulletin will aid in its prompt recognition whenever it does appear. In many other sections where it is present it has not as yet become established as a serious weed. To the readers in such localities we wish to bring warning and to urge them to take prompt measures to eradicate the plant before it gains a firmer foothold.

*Names.* This plant now so common as a weed was introduced from Europe by florists under the name of orange or golden hawkweed.* Its showy red flowers, mode of introduction and rapid spread as a weed have led to the application to it of a variety of other popular names in this State, such as: paint-brush, red paint-brush, ladies' paint-brush, flora's paint-brush, devil's paint-brush and red daisy.

We shall use the name by which it is more widely known, namely, orange hawkweed.

*Botanical Relationship.*—The appearance of the flower, Fig. 2, and the character of the fruit, Fig. 4, at once suggest the fact that it is a close relative to the dandelion and daisy, that is, a member of the Composite Family botanically speaking.

This is of itself presumptive evidence against the plant, as this family has given us a larger number of bad weeds than has any other. Some of the more common of these, in addition to this orange hawkweed, the dandelion and white daisy, are the yellow daisy, the various thistles, golden rods, everlastings, elecampane, devil's pitch-forks, may-weed, yarrow, tansy, rag-weed, wormwood, burdock, chicory, goat's beard.

*Popular Description.*—It is fortunate that this weed is a plant so conspicuous and so easily recognized. The flower heads, as shown in Fig. 2,

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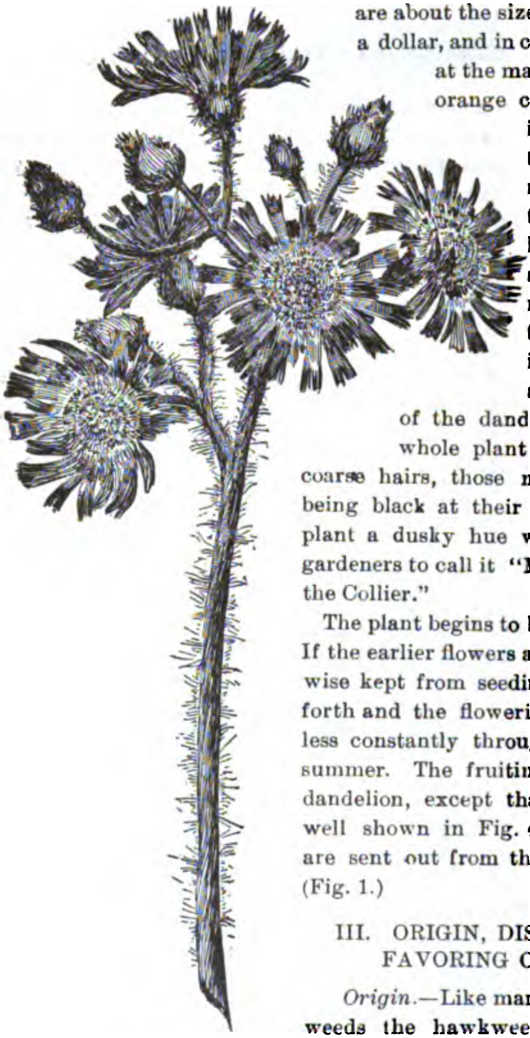
* Its botanical name is *Hieracium aurantiacum, L.*



2. CLUSTER OF FLOWERS.
(Natural size.)

are about the size of a silver quarter of a dollar, and in color they are flame-red at the margins, shading into an orange center. They are borne in clusters of five to twenty or more, on a nearly leafless stem one to two feet high. The leaves are rather long and narrow, forming a rosette-like cluster at the base of the flowering stem, resembing in arrangement the leaves of the dandelion. (Fig. 1.) The whole plant is covered with long, coarse hairs, those near the flower clusters being black at their base. This gives the plant a dusky hue which has led English gardeners to call it "Mr. Collier," or "Grim the Collier."

The plant begins to blossom early in June. If the earlier flowers are cut down or otherwise kept from seeding new stalks are put forth and the flowering continues more or less constantly throughout the rest of the summer. The fruiting head resembles the dandelion, except that it is smaller, as is well shown in Fig. 4. Numerous runners are sent out from the base of each plant. (Fig. 1.)

## III. ORIGIN, DISTRIBUTION AND FAVORING CONDITIONS.

*Origin.*—Like many others of our worst weeds the hawkweed came to us from Europe.* It is a native of the Alpine regions of Europe where its showy blossoms render it a favorite with flower hunting tourists. Curiously it is entirely unknown as a weed plant in its native land. Even in England, where it has been commonly introduced as a flowering plant in gardens, it has shown no tendency to become a pest. It was introduced into the Eastern United States as a garden plant sometime before 1818, though apparently not scattered very widely until more recently. It was quite widely distributed through Vermont some twenty-five or thirty years ago as a desirable flower by seedsmen and through its use as a premium by an agricultural journal. Its hardiness and tendency to spread as a weed were noticed at that time by some of those who cultivated it and it was in a few cases promptly eradicated. By others it was allowed to remain and spread. Its introduction since that time into new localities in the State has been quite largely as an ornamental plant by those who were either ignorant or careless of its weedy propensities. Mr. C. G. Pringle collected plants extensively in Northern Vermont for several years following 1870, and he states that he first saw this plant outside of the garden in 1873, when he came upon a cluster of it by the roadside near Shelburne Falls. Curiously the history of its spread at other points in New England begins at about this same date. It attracted but little attention as a weed until ten or twelve years ago when it had gained a thorough foothold in many places. Since this time it has spread rapidly and persistently.

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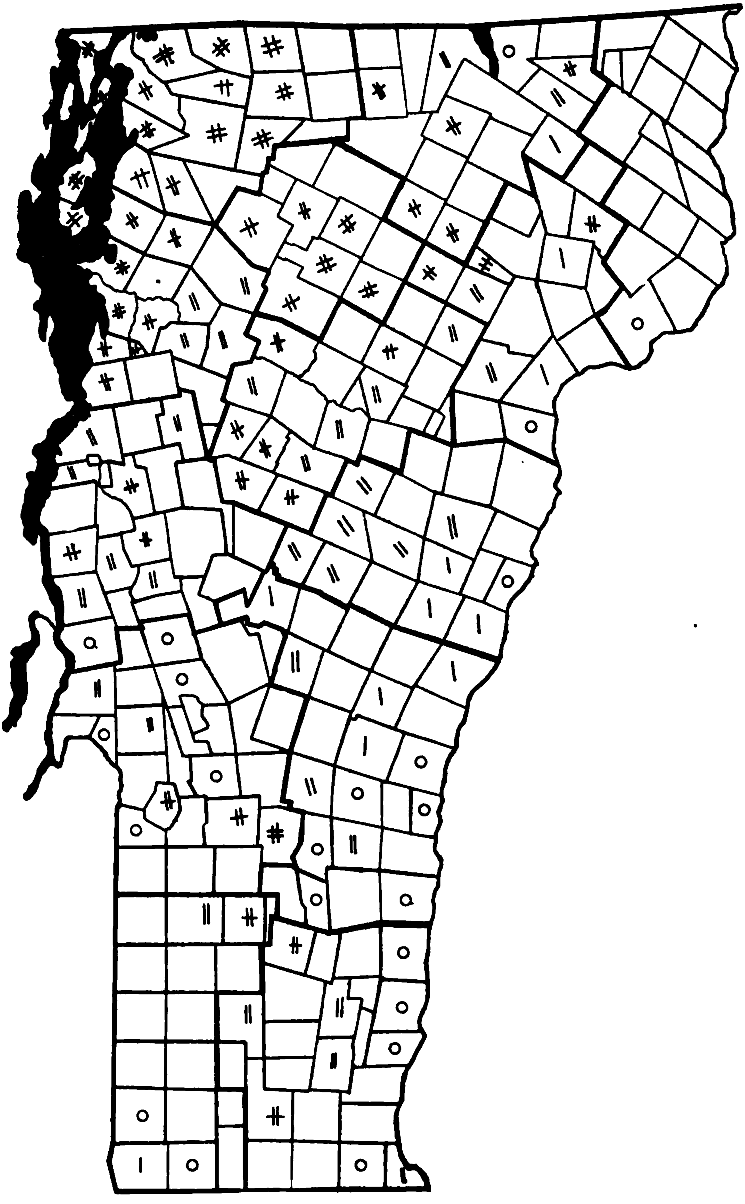
* Our thanks are especially due to Professor Carruthers, of England, and Doctors Stebler, of Switzerland, and Nobbe, of Saxony, for information concerning the occurrence of this plant in Europe.

*Present Distribution*.–The orange hawkweed has been quite widely introduced as a garden flower into the Eastern States and Canada, but in many places the conditions appear unfavorable for its development as a weed. Outside of Vermont, it has been reported as troublesome in Maine, New York, Pennsylvania and Eastern Canada.

Professor Harvey of the Maine Experiment Station writes that "it occurs in nearly every portion of this State and is spreading." In New York it is a bad weed in some places. Professor Rowlee of Cornell University says: "This plant has become a most vile and pernicious weed and widespread. It is upon a great many farms in Oswego Co., indeed I should think it too permanently established to be eradicated without great expense." It also occurs in the region of the Catskill Mountains. In Pennsylvania, so far as learned, it is less widely distributed, although reported as a very serious weed in the northeastern portion of the State and as occurring in other parts. Its introduction into northeastern Ohio was reported this last year by Professor Selby of the Ohio Station. Professor Fletcher of the Ottawa Experimental Farms, considers it one of the serious weed pests of certain portions of Eastern Canada.

It does not seem to have excited serious alarm in Massachusetts, Rhode Island or Connecticut, although its occurrence in all these states has been reported to us.

The relative distribution and development of the weed in Vermont is indicated on the map upon the next page. A glance shows that it is most troublesome in the northwestern portions, Franklin, Grand Isle, Lamoille and Chittenden counties being thoroughly infested by it. In the remaining portions of the State it is widely introduced, though in many cases not as yet recognized as a serious weed.



3. THE DISTRIBUTION OF THE ORANGE HAWKWEED IN VERMONT.

As reported to the Experiment Station in 1896. No reports received from towns so marked.

Meaning of the marks:—The circle (O) indicates that the hawkweed has not been seen; one line ( | ) indicates that it occurs but sparingly; two lines (‖) that it is well scattered but not yet recognized as a bad weed; three lines (+|) that it is well established as a weed; four lines (the double cross) that it is a very bad weed.

*Conditions Favorable to its Development.*—The orange hawkweed is a native of the mountainous regions in Europe, and has not, in its native country, spread to the lowlands. The prostrate habit of the leaves and runners, their abundant covering of hairs, and the rapid development of the flowers and fruit all suit it to the short, cool summers of higher altitudes. It retains its love for the mountains in this, its adopted home. We have observed it thriving at its best and spreading rapidly in the hill pastures near Smugglers' Notch, in the Green Mountains. Thanks to its feathered fruit, its seed is easily wafted up the mountain side, and vigorous flowering plants were collected last July near the summit of Mount Mansfield at an altitude approaching 4,000 feet.

This inbred love for alpine regions doubtless explains why its spread in Northern New England and Canada has been more rapid than that farther south. A study of its history and present distribution leads to the belief that the plant as it occurs in Vermont to-day is adapting itself to conditions unknown to its European ancestors. Where thoroughly established, as it is in the northwestern portions of the State, it seems now almost equally at home and aggressive upon all soils from the sandy fields to the heaviest undrained clays, and at all altitudes, from the sides of Mount Mansfield to the shores of Lake Champlain. It seems probable, therefore, that it will soon spread as a weed over the more southern and eastern parts of the State if allowed to remain and adapt itself to the conditions surrounding it there. It is certainly too dangerous a plant to be tolerated in any place where it is still possible to eradicate it.

## IV. DAMAGE DONE AND MODE OF SPREADING.

*Damage done by it.*—It is in permanent grass lands alone that the orange hawkweed causes serious damage. In soil suited to thorough cultivation, which can be kept in good fertility and where short rotations are practiced, neither this nor any similar weed need offer great difficulty. The lawn, the roadsides and the hill pastures are the places where its invasions are most to be dreaded. Where once well established in such situations it has spread unless checked by vigorous measures until it occupies the soil to the practical exclusion of grass or other plants.

*In the lawn* it thrives under the lawn mower. To test its fighting qualities under such treatment a small area in a June grass (Kentucky blue grass) lawn where the hawkweed was gaining entrance was staked off and mowed once each week throughout the summer. The result in September was that this area was a perfect mat of the weed, the June grass having succumbed more quickly here than where it was less closely mown.

*In the roadside* where it once becomes established it will never be eradicated without greater effort than is made by the ordinary road commissioner or other interested person. Mowing, which checks most weeds, actually favors this plant by removing the grass and exposing its low spreading leaves to the sunlight. Unless it is done at very frequent intervals, mowing does not prevent it from seeding.

*In hill pastures* the hawkweed is capable of causing the greatest loss to Vermont farmers. Where it once becomes established it ultimately kills out all grass, and there is probably no practical means of eradicating it from large areas of this nature. Such pastures could only be abandoned to the growth of forest trees. While in some cases this forced desertion might mean ultimate gain to the community, in many instances it would entail serious loss. Fortunately this weed having begun its spread from the garden has invaded the adjacent cultivated soil first, and these remoter hill pastures are the last areas to be reached. In most cases they may still be preserved.

*Modes of Propagation and Distribution.*—In order intelligently to discuss means of eradication we should observe the modes of propagation and distribution of the weed. Like most bad weeds it has more than one. The plant is a perennial. It spreads by means of slender root-stocks or underground stems, and more especially by numerous runners which are sent out from the base of the plant in much the same manner as strawberry runners. (Fig. 1.) So numerous are these that in a bed of the weed the surface of the ground is completely matted with them. Careful examination of a single plant and its progeny last August showed nearly thirty new plants originating thus by runners from a single old plant. Where the flowering stems are cut off as in a lawn, the plant forms runners even more vigorously than this.

In addition each plant bears great numbers of fruits or seeds, which like those of the dandelion are provided with tufts of hairs so that they float on the slightest breeze and are thus borne long distances. (Fig. 4.) The same plant may bear several crops of flowers and fruit in one year, a field of the weed being in more or less continuous blossom from June to November. The number of seeds produced during the season by a single plant, as estimated from various counts made last summer, would average about twelve hundred. The first and largest crop of seed is ripened before hay is cut, so that the seed is scattered in the hay.

## V. MEANS OF ERADICATION.

The complete extermination of any weed when once it is thoroughly established, is a practical impossibility. The hawkweed is in Vermont to stay. Nevertheless, prompt action rightly directed, may keep it from becoming a more serious pest. This weed has probably increased tenfold in the State during the past decade, yet it is not one-tenth as bad as it may become in the State as a whole.

The first and most important means of fighting any weed where it is possible to practice it, is cultivation.

4. THE HAWKWEED IN FRUIT.

Three hundred seeds ready to sail away on the next breeze.

*Clean Cultivation.*—In the case of this weed, pulling by hand is a waste of time. Any attempt at this will leave numerous runners, or root-stocks in the soil and will at best only give the weed a temporary set back. For the same reason cutting off the plants with a hoe is not likely to be successful unless followed up repeatedly. The hawkweed readily yields, however, to careful plowing, followed by thorough cultivation. We have found by experiment that it is possible to completely exterminate the plant in one year in this way. For practical purposes, however, it is recommended that the land be kept in cultivation for two or three years, planting to some hoed crop, like corn or potatoes, which are given more thorough cultivation than is usual. Cases are known where the land has been carelessly cultivated for several years without destroying the weed.

When such thorough cultivation with a horse is not practicable, and *in all cases where there is only a small amount of the weed present*, a very effective remedy is found in salt.

*Salt.*—This agent has long been used in fighting weeds, but in most cases such heavy applications are required as to destroy the grass and other useful plants along with the weeds. The orange hawkweed is, however, remarkably sensitive to salt, being quickly killed by applications which do not injuriously affect most other plants.

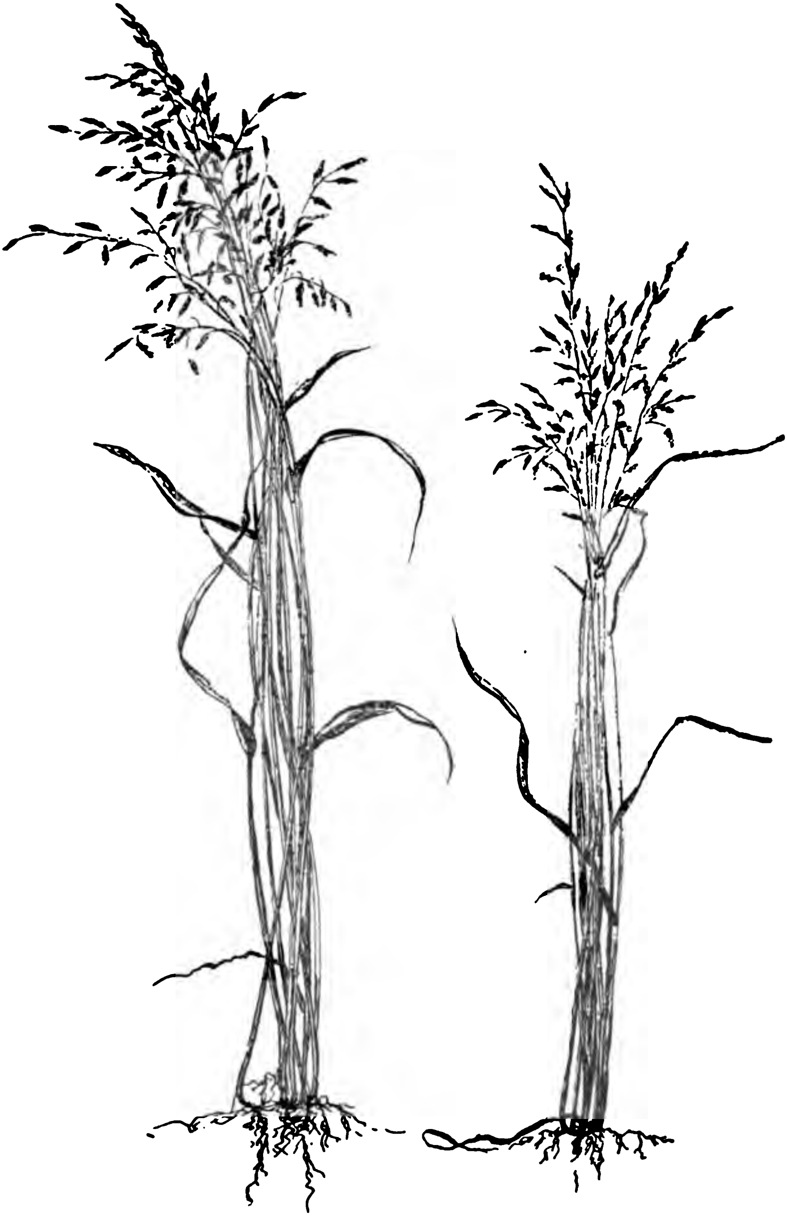
In order to determine the effect of varying amounts of salt upon both the weed and the grass, adjoining plots were staked out in a piece of grass land which was badly infested with the weed. Dry salt was sown broadcast upon these at the rates respectively of 1,000, 2,000, 3,000, 4,000 and

6,000 pounds per acre. The heaviest application entirely destroyed the hawkweed and the grass also. *All of the lighter applications proved ultimately beneficial to the grass,* and in varying degree destructive to the weed. Most of the weed was killed by the 2,000 pound application and *every plant of it was killed by the application of 3,000 pounds per acre.* These applications were made in May. In July the grass (Fescue) upon the salted plots was very noticeably larger and of a richer dark green color than was the grass on the adjoining soil where no salt had been applied. In order to make a more accurate comparison ten stalks of the grass of average size were cut from each plot, photographed and weighed. Figure 5 is a drawing from this photograph and shows the relative appearance of the grass from the two plots. The ten plants from the unsalted plot weighed 14 grams, while those from the plot which had received 3000 pounds of salt per acre weighed 26 grams, or *nearly twice as much.*

Without going further into the details of the experiments we find, after repeated trials, that where the weed is thoroughly established so as to cover the entire ground, 18 pounds per square rod or 3000 pounds per acre suffice to destroy every plant of the hawkweed. In all cases upon our soil such applications of salt benefited the grass, but injured or killed the clover. When the weeds are scattered much less salt will suffice. If but a few plants occur a small handful of salt scattered over the leaves will do the work.

It must not be inferred that similar applications of salt will prove equally beneficial by doubling the grass yield on all soils and under all circumstances. Salt acts as a fertilizer on lands not because of any plant food it contains but, among other reasons, because it may so act on insoluble food elements already present in the soil as to render them more soluble and hence more readily available to the plant. Salt will therefore prove more beneficial on some soils than on others. It seems probable from our experiments however, that this weed can be destroyed in any soil by applications of salt which will be at the same time beneficial rather than injurious to the grass. Some of the gains in our experiments must of course be attributed to the indirect benefit to the grass resulting from the destruction of the weeds.

Why does the salt kill the hawkweed so quickly? This has not been fully determined, but there is no doubt that it is chiefly by its action in withdrawing water from the tissues of the plant. Salt has a strong attraction for water, so that when dry salt is placed in a moist atmosphere or on a moist surface it absorbs water rapidly. This action occurs when the salt comes in contact with the tissues of the hawkweed. If we place a few crystals of salt on a dry leaf of the weed and examine it after a short time we no longer find dry crystals but drops of salt water. At the same time the leaf has wilted, showing that the water has been drawn from the interior of the leaf.



Salted. No salt.

5. THE RELATIVE EFFECTS OF SALT AND OF HAWKWEED ON GRASS.

The cluster at the right grew in the midst of hawkweed; that at the left was similarly situated but 3.000 pounds per acre of salt had been applied, the result being the entire destruction of the weed and the doubling in the weight of the grass. (See page 12.)

As might be expected from the preceding results, we have found the salt to be much more effective in killing the plant when it is applied dry than when in solution, more effective when placed on the leaves than when on the soil about the roots and more effective on a dry, hot day than in damp or rainy weather.

It is interesting to note that some of the more soluble chemicals used in the manufacture of commercial fertilizers may be used to kill this weed in the same way as salt, although none of them are so active as the salt. Muriate of potash has proved most effective in our experiments. The amounts required, however, involve an expense too great to make their use wise under most circumstances.

The cheapest salt obtainable is recommended for use, as in our experiments this has proved about as effective as the purer table salt. In most of this work the Experiment Station has used salt bought from O. J. Walker & Bro. of Burlington, for $5.50 per ton, and it may be obtained from any of the larger manufacturers of commercial fertilizers at similar prices. Ex-Governor C. S. Page of Hyde Park, Vt., sells the refuse salt from his hide warehouses at from $3.00 to $4.00 per ton. This is less pleasant to handle but contains some refuse matter which adds slightly to its fertilizing value. The expense, therefore, of salt for ridding land of this weed, even when it is badly infested, is not extreme, and in cases where the weed is only beginning its invasion it is very slight.

**In all cases where there is only a small amount of the weed present we would urge the use of salt as the quickest and surest means of destroying it.**

## VI. CONCLUSION AND QUERIES.

In conclusion we wish to thank the many farmers who have replied to the inquiries sent from the Experiment Station concerning this weed, and to urge that others having had experience with it will send further information, so far as they can. More facts are desired as to the present distribution of the plant in Vermont and elsewhere, when and how it was introduced, the amount of injury it is doing as a weed, and the results of any experience in fighting it by cultivation, the use of salt or other methods. It is hoped that many readers of this bulletin will answer the accompanying inquiries and return the same to the Station. With this added data and the results of another summer's experiments, a more complete account of this weed may then be presented in the next Annual Report.

Farmers and others interested are also invited to send specimens of new or unknown plants, especially if they appear suspicious. We will undertake to identify them and promptly advise the sender as to their character. New weeds are each year introduced into the State from various sources and it is only by such constant vigilance that their ultimate spread can be prevented.

**Readers of this bulletin are urged to answer the following questions and mail them to the Experiment Station.**

1. Does the Orange Hawkweed grow in your vicinity? If so, to what extent?

2. When and how was it introduced?

3. Is it now regarded as a serious weed by you and by people generally in your vicinity?

4. Has it spread rapidly?

5. In what kind of soil and associated with what cultivated plants is it proving most serious?

6. Have you had any experience with or knowledge of any attempt to eradicate the weed? If so, what means were used, and with what results?

7. What five weed plants are proving most troublesome in your vicinity?

8. Any further remarks concerning these or other weeds.

SIGNATURE..........................................

Date......................... POST OFFICE................................

(Address envelope "Experiment Station, Burlington, Vt.")

1897.

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# VERMONT
# AGRICULTURAL EXPERIMENT STATION.

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## BULLETIN No. 57.

MARCH, 1897.

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## Analyses of Commercial Fertilizers.

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II. Schedule of Trade Values.—Pages 20-24.
III. Observance of the Fertilizer Law.—Page 25.
IV. Licensed Fertilizers Sampled by Station.—Pages 25-28.
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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 57.

# ANALYSES OF COMMERCIAL FERTILIZERS.

BY J. L. HILLS, B. O. WHITE AND C. H. JONES.

## I. STATEMENT REGARDING ANALYSES.

The present bulletin contains analyses of leading brands of goods of each manufacturer licensed to sell in Vermont excepting the Read Fertilizer Co. and the Russia Cement Co., which are not included because no samples of their goods have as yet been found by our sampling agents. Usually composite samples (mixtures of equal portions of several samples of the same brand taken at different points) have been analyzed, but in a few cases single samples only have been taken.

The choice of brands for immediate analysis and early publication is based largely upon the frequency with which they have been found in the search for samples during the three past as well as during the present season, this being regarded as an indication of comparatively extended use.

A second bulletin of analyses will be issued about April 20th, in which it is expected to include all the brands most commonly sold in the State. A third will be issued in May and will contain the analyses of the brands less widely used, together with a reprint of the analyses given in the March and April bulletins.

All samples are taken by agents of the Experiment Station from this year's shipments in the hands of local dealers, and represent therefore exactly what the purchaser is getting.

For detailed data regarding the meaning of the terms used in fertilizer analysis, the principles underlying the use of fertilizers, the elements of plant food, the sources of crude stock or raw materials used in manufacture, the commercial and agricultural values of fertilizers, the arguments in favor of and methods of home-mixing, the rational and economical selection, purchase and use of fertilizers, the reader is referred to Bulletins 47 and 52 of this Station which will be sent to any address upon application.

## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this State, in 1897, is the one agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut, New Jersey and Vermont, after a careful study of prices ruling in the large markets of the New England and Middle States.

### TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1896 AND 1897.

| | 1896<br>cts. per lb. | 1897<br>cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 15½ | 13½ |
| " in nitrates | 13½ | 14 |
| Organic nitrogen in dry and fine ground fish, blood and meat and in mixed fertilizers | 14 | 14 |
| " " in cotton seed meal | 12 | 12 |
| " " in fine ground bone and tankage | 13½ | 13½ |
| " " in medium " " | 12 | 11 |
| " " in coarse " " | 9<br>8 | 8 |
| Phosphoric acid soluble in water | 5½ | 5½ |
| " " " in ammonium citrate* | 5 | 5 |
| " " in dry fine ground fish, bone and tankage | 5 | 5 |
| " " in medium bone and tankage | 4 | 4 |
| " " in coarse " " | 2½<br>2 | 2½ |
| " " insoluble (in ammonium citrate) in mixed fertilizers | 2 | 2 |
| Potash as sulphate and in mixtures free from muriate (or chlorids) | 5 | 5 |
| Potash as muriate | 4½ | 4½ |

The above trade values are, as nearly as can be estimated, the average figures at which, in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st. plus about 20 per cent, in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable average retail price in the large markets of standard raw materials such as, Sulphate of Ammonia, Nitrate of Soda, Muriate of Potash, Sulphate of Potash, Dried Blood, Plain Superphosphate, (AcidPhosphate), Azotin, Dry Ground Fish, Ammonite, Cotton Seed Meal, Bone, Tankage and Ground South Carolina or Florida Rock.

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*Dissolved from 2 grams of the unground phosphate, previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes at 65 degrees C., with agitation once in five minutes; commonly called "reverted," or "back-gone" phosphoric acid.

### APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS

The above trade values are applied to the valuation of superphosphates and mixed goods as follows:

The organic nitrogen is valued at 14 cents per pound, it being assumed that it is obtained from such materials as dried blood, tankage, cotton seed meal, ground fish or nitrogenous substances of equally good quality.

Nitrogen in the form of nitrate of soda and sulphate of ammonia is valued at 14 and 13½ cents per pound respectively.

Soluble, reverted and insoluble phosphoric acids in mixed fertilizers are valued at 5½, 5 and 2 cents per pound respectively.

The potash is valued at 4½ cents per pound, the price of that ingredient in kainit and muriate if there is sufficient chlorin in the fertilizer to unite with all the potash; if not, such as is not thus united is valued at 5 cents per pound, the price of that ingredient in high grade sulphate.

The "Station valuation" of a fertilizer may be obtained by *multiplying the given per cent. of each constituent(nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.*

### COMMERCIAL VALUE OF COMMERCIAL FERTILIZERS.

In order that there may be no misconception and that the reader may clearly appreciate what these valuations are and what they are not, it is our custom to repeatedly call attention to the fact that **the Station valuation of a brand of fertilizer does not represent its proper selling price at the point of consumption.** Neither should it be inferred that the ingredients in the brand in question have of necessity the commercial value indicated. It may be greater or less than is shown. The Station does not pretend dogmatically to state the commercial worth or valuation of any given fertilizer. Its "valuations" should be construed as showing the *retail trade value or cash-cost of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in unmixed standard raw materials of good quality, at the seaboard.*

The following explanations may serve to render these points yet more clear.

1. The trade values scheduled on page 20, of this bulletin represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, respectively, can now be purchased, in their various forms, for cash, at retail, in the large markets of the New England and Middle States. They are based in part upon the ton prices at which certain classes of goods are offered to actual consumers by manufacturers and brokers, and in part upon the wholesale prices as quoted during the six months preceding March 1st, plus 20 per cent.

2. These trade values do not include the charges for mixing, bagging, storage, freight, commissions to agents and dealers, selling on long credit,

bad debts, interest on investment, depreciation of plant, profits, etc.

They represent the retail prices of nitrogen, phosphoric acid and potash, at the seaboard (Boston, New York, etc.) singly and unmixed. In ordinary complete fertilizers the three ingredients are mixed together, but this is not a necessary condition of their use. In their unmixed condition they are ready for use by the farmer, if it is desired to apply them separately.

An illustration may serve to make the above statements more clear. A farmer wishes a ton of fertilizer similar to the well-known brands sold in this State. If he purchases in Boston or New York fifty (50) pounds of nitrate of soda, three hundred and fifty (350) pounds of dried blood, one hundred and twenty five (125) pounds of muriate of potash and fourteen hundred and seventy five (1475) pounds of dissolved South Carolina rock, known in the trade as "acid phosphate," and mixes these ingredients together, he will have a complete fertilizer analyzing very closely like the average goods sold in Vermont in 1896, and not essentially different from many standard brands now in the market.

The cost of the ton after mixing (if the farmer prefers to mix the ingredients himself) will be made up as follows:

(*a*) Cost of the materials in the markets.

(*b*) Cost of transportation.

(*c*) Cost of mixing.

The first item (*a*) entering into the total cost is the only one included in the "valuation." If there is added to this one item not only the charges for transportation and mixing but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary complete fertilizers, when delivered at or near the place of consumption.

It is clear, therefore, that the selling price at the point of consumption must of necessity exceed the "valuation," the excess representing the manufacturer's charges for converting raw materials into finished products, for freighting and for selling the same.

Since the cost of mixing and selling must of necessity vary somewhat with different companies, and since freight rates to the various sections of the State are quite unlike, it is unsafe to assign any arbitrary sum to cover these charges. These can be best estimated by the consumer to fit his local conditions.

"Valuations" may be found useful:

(*a*) To show whether a given fertilizer is worth its cost from the *commercial* standpoint.

(*b*) As a common basis on which to compare the *commercial* values of different brands, enabling buyers to note whether prices asked are warranted by values contained.

In 1895 the average selling price of one hundred and ten brands sold in Vermont, was $30.90 per ton, the average "valuation," $19.73, and the difference, $11.17, an advance of 57 per cent. on the "valuation," which, it will be remembered, simply indicates the reasonable retail cash cost of similar amounts of unmixed ingredients in standard raw materials of good quality at the seaboard. Or, stating the case another way, on the average for each dollar invested in commercial fertilizers in the Vermont trade of 1896, 64 cents was paid for plant food, and 36 cents for mixing, bagging, freighting and selling it. ($19.73+$30.90—0.64.) In many brands less than sixty and, in some, less than fifty cents worth of plant food were bought for a dollar. If the selling price does not exceed the valuation more than thirty to thirty-five per cent., it may not be too high a price, but in proportion as the excess increases beyond this point there is reason to question the economy of the purchase.

An illustration of the method of making this comparison may prove helpful. A brand of fertilizer containing 2 per cent. of nitrogen, 9 per cent. of total phosphoric acid, 8 per cent. of available phosphoric acid and 6 per cent. of potash sells at consumer's depot for $33. In the absence of analysis guarantee* may be taken as a basis of calculating "valuation," which is found to be $20.20. $20.20÷$33=0.61. A dollar buys sixty-one cents worth of plant food and thirty-nine cents is paid for manufacture, transportation and selling expenses. $33÷$20.20=1.60. The brand costs sixty per cent. more than its "valuation."

It is usually found that the low-priced brands are (commercially) the most costly. Last year's inspection developed the fact that, "a dollar spent for the average low priced brands (below $30) brought 60.4 cents worth of plant food at retail seaboard prices; a dollar spent for average medium price goods ($30 to $35), 64 cents worth; and a dollar spent for average high grade goods (above $35), 68.7 cents worth. The very evident reason for this is that the cost of mixing, bagging, freighting and selling low grade material or make-weight is as great as when higher grades are handled. . . . . It is very doubtful whether at present prices for farm produce, many farmers can afford to pay from 40 to 52 cents out of every dollar invested in fertilizers to the manufacturer, laborer, railroad and dealer. Yet on the other hand, by careful choice, or, under some circumstances, by the practice of home mixing, the use of commercial fertilizers even at present crop prices may prove profitable, particularly if supplemented by proper feeding of farm stock and care for the manure."

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*In such cases care should be taken to properly interpret the guarantee, to use minimum guarantee only, etc. See pages 25-26, Bulletin 52.

### AGRICULTURAL VALUE OF COMMERCIAL FERTILIZERS.

It often occurs that consumers lay too much stress upon "valuation" and too little upon the analysis. The valuations stand in no direct or necessary relation to the comparative profits which may result from the use of the various brands. Their significance is almost purely commercial. A brand rich in nitrogen, the most costly of the three deficient essential elements of plant food, may value high, and yet the crop returns, on a soil loaded with nitrogen or with a crop needing but little artificial supply of this ingredient, may prove inferior to those obtained with a brand rich in other constituents less valuable commercially, but for which soil or crop hunger.

Quite generally, however, a high agricultural value determines somewhat the trade or commercial value of raw materials, yet exceptions exist which render the trade value an uncertain guide to farm application.

There are several points which should be borne in mind in economical and rational purchase.

1. Previous experience obtained personally or by careful, observing, reliable neighbors with similar goods on the same or similar soil with the same crops.

2. Reputation of the firm offering the goods.

3. The advantages and disadvantages of home mixing as compared with the purchase of "mixed goods."

4. The character and amount of barn yard manure on hand.

5. The advisability of buying concentrated by-products (cotton seed, linseed and gluten meals, etc.,) of growing leguminous crops more largely, being thus enabled to feed rations rich in portein ; of using absorbents and "fixatives" (land plaster, kainit, etc.,) in the stable, thus obtaining a more highly nitrogeous manure ; in short, "fertilizing by feeding," buying less nitrogen in commercial fertilizers and more in fodders and feeds.

6. The character, previous cropping and manuring of the soil.

7. The demands of the crop upon the plant food of the soil.

8. The analysis of the goods under consideration and its fitness for soil, crop, and as a supplement to home manurial supplies.

9. The forms in which the ingredients occur; nitrogen as nitrates, organic matter, etc., potash as muriate, as sulphate, etc.

10. The relation between selling price and "Station valuation."

These ten points, of which "valuation" is but one, are not of necessity stated in the order of their relative importance.

## III. OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal*. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however, that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not effected by the restrictions of the law.

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | 92 State St., Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | 92 State St., Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co. | State St. and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133-137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 27 William St., New York, N. Y. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 18 | Parmenter and Polsey Co | Peabody, Mass. |
| 19 | Russia Cement Co | Gloucester, Mass. |

## IV. LICENSED FERTILIZERS SAMPLED BY STATION.

### Bowker Fertilizer Co., Boston, Mass.

**5309. Hill and Drill Phosphate**; from stocks of A. E. Fuller, West Woodstock; G. A. Wales, South Barre.

**5307. Stockbridge Corn Manure**; from stocks of S. A. Reed, Windsor; D. L. Wilkins, West Windsor; A. E. Fuller, West Woodstock.

**5308. Stockbridge Potato Manure**; from stocks of A. E. Fuller, West Woodstock; S. A. Reed, Windsor; G. A. Wales, South Barre.

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* The American Fertilizer Co., Boston, Mass., has signified intention to take out a license.

### Bradley Fertilizer Co., Boston, Mass.

**5281. Corn Phosphate**; from stocks of F. C. Perry, South Pomfret; H. P. Munson, Morrisville; John Spaulding, Warren; H. A. Pond, East Berkshire.

**5297. Eclipse Phosphate**; from stocks of E. H. Slayton, Woodstock; John Spaulding, Warren; Burt Bros., Enosburgh Falls.

**5298. Potato Fertilizer**; from stocks of John Spaulding, Warren; F. C. Perry, South Pomfret; Burt Bros., Enosburgh Falls; H. P. Munson, Morrisville.

**5299. Vermonter**; from stocks of E. Foster, South Royalton; Burt Bros., Enosburgh Falls; H. A. Pond, East Berkshire; George Shorey, Lyndonville; G. H. Tupper, Bethel; Maynard & Marsh, Sheldon.

**5300. XL Superphosphate of Lime**; from stocks of E. A. Morse Calais; E. H. Slayton, Woodstock; Maynard & Marsh, Sheldon.

### Clark's Cove Fertilizer Co., Boston, Mass.

**5225. King Philip Alkaline Guano**; from stock of G. L. Swan, North Tunbridge.

### Cleveland Dryer Co., Boston, Mass.

**5291. Corn and Grain Phosphate**; from stocks of D. A. Spooner, Randolph; E. J. Brunson, St. Albans; E. Douglass & Son, Morrisville.

**5301. Fertilizer for all Crops**; from stock of G. H. Stimets, Highgate; M. Hunt, North Troy; E. H. Slayton, Woodstock.

**5285. Potato Phosphate**; from stocks of E. H. Slayton, Woodstock; D. A. Spooner, Randolph; E. Douglass & Son, Morrisville.

### E. Frank Coe Co., New York, N. Y.

**5304. Columbian Corn Fertilizer**; from stocks of Nelson & Kent, Montpelier; H. W. Hibbard & Co., South Ryegate; Dan Moody, Stowe; W. V. Phelps, Enosburgh Falls.

**5287. Columbian Potato Fertilizer**; from stocks of Nelson & Kent, Montpelier; E. S. Stratton & Son., Craftsbury; B. Combs, East Berkshire; H. L. Page, Essex Centre.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**5303. Ammoniated Bone Superphosphate**; from stocks of Isaiah Benson, West Woodstock; J. B. Brock, West Newbury; Albert Lamberton, Marshfield.

**5302 Ammoniated Corn Phosphate**; from stocks of C. C. Fisher, Wolcott; J. B. Brock, West Newbury; Isaiah Benson, West Woodstock.

### Cumberland Bone Phosphate Co.. Boston, Mass.

**5305**. **Superphosphate** ; from stocks of H. N. Stanhope, Richford ; J. H. Hewitt, South Royalton ; E. B. Moody, Waterbury Center.

### Great Eastern Fertilizer Co., Rutland, Vt.

**5286** **Corn Phosphate**; from stocks of E. L. Winslow, Woodstock ; G. E. Graham, North Hartland ; J. S. Drew, Lyndonville ; B. R. Holmes Cambridge.

**5293**. **General Fertilizer**; from stocks of E. L. Winslow, Woodstock ; G. E. Graham, North Hartland ; J. S. Drew, Lyndonville ; B. R. Holmes, Cambridge.

**5294** **Grass and Oats Fertilizer**; from stocks of E. L. Winslow, Woodstock ; G. E. Graham, North Hartland ; J. S. Drew, Lyndonville ; B. R. Holmes, Cambridge.

**5292**. **Potato Manure**; from stocks of E. L. Winslow, Woodstock ; G. E. Graham, North Hartland ; J. S. Drew, Lyndonville ; B. R. Holmes, Cambridge.

### Lister's Agricultural Chemical Works, Newark, N. J.

**5290**. **Special Potato Fertilizer**; from stocks of J. H. Russell, Underhill ; H. C. Lamphier, Hyde Park ; W. H. Wheatley, Hardwick ; C. L. Hodges, Randolph.

**5283** **Success Fertilizer**; from stocks of J. H. Russell, Underhill ; H. C. Lamphier, Hyde Park ; W. H. Wheatley, Hardwick ; G. W. Pratt, West Derby ; C. K. Thompson, Woodstock.

### Lowell Fertilizer Co., Boston, Mass.

**5229**. **Swift's Lowell Bone Fertilizer**; from stock of C. D. Loukes, Highgate.

### Pacific Guano Co., Boston, Mass.

**5306**. **Soluble Pacific Guano**; from stocks of A. T. Smith, West Topsham ; R. B. Pixley, Norwich ; W. F. Clark, Glover.

### Parmentor and Polsey Co., Peabody, Mass.

**5256**. **Plymouth Rock Brand**; from stock of H. Osgood, Cabot.
**5257**. **Star Brand Superphosphate**; from stock of H. Osgood, Cabot.

### Quinnipiac Co., Boston, Mass.

**5282**. **Corn Manure** ; from stocks of N. W. Bates, Essex Center ; O. J. Lowrey, Jericho ; W. A. Jackson, Greensboro ; W. J. Lawrence, Waterford.

**5289**. **Potato Phosphate**; from stocks of N. W. Bates, Essex Center; O. J. Lowrey, Jericho; W. A. Jackson, Greensboro; J. H. Hewitt, South Royalton; W. J. Lawrence, Waterford.

### Standard Fertilizer Co., Boston, Mass.

**5277**. **Fertilizer**; from stock of C. W. Atherton, Waterbury.

### Henry F. Tucker Co., Boston, Mass.

**5296**. **Imperial Bone Superphosphate for All Crops**; from stocks of D. A. Spooner, Randolph; R. Dwinell, Glover; H. H. Scott, Bakersfield.

**5310**. **Imperial Bone Superphosphate for Potatoes**; from stocks of R. Dwinell, Glover; M. A. Nelson, Montpelier.

### Williams & Clark Fertilizer Co., New York, N. Y.

**5295**. **Americus Corn Phosphate**; from stocks of J. H. McDowell, Greensboro; F. T. Russell, East Hardwick; G. H. Soule, Fairfield; A. W. Bailey, Montpelier; W. B. Hutchinson, South Pomfret; A. W. Varney, Hartland Four Corners.

**5284**. **Ammoniated Potato and Tobacco Manure**; from stocks of J. H. McDowell, Greensboro; W. B. Hutchinson, South Pomfret; A. W. Varney, Hartland Four Corners; A. W. Bailey, Montpelier.

**5288**. **Royal Bone Phosphate**; from stocks of J. H. McDowell, Greensboro; F. T. Russell, East Hardwick; F. H. Percivall, Glover; A. W. Varney, Hartland Four Corners.

### EXPLANATION OF TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 20 of this bulletin, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers,

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

## V. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. Found. | Total. Guaranteed. | Available. Found. | Available. Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| 5309 | Bowker's Hill and Drill Phosphate | 0.81 | .... | 1.61 | 2.42 | 2.5 | $6.78 | 9.00 | 3,08 | 1.70 | 13.73 | 12. | 12.03 | 9. | $18.61 | 2.39 | 2. | $2.15 | 5309 |
| 5307 | Bowker's Stockbridge Corn Manure | 1.24 | .... | 2.08 | 3.32 | 3.25 | 9.30 | 6.69 | 2.75 | 1.80 | 11.24 | 10. | 9.44 | 8. | 10.88 | 7.39 | 6. | 6.65 | 5307 |
| 5308 | Bowker's Stockbridge Potato Manure | 1.50 | .... | 1.90 | 3.40 | 3. | 9.52 | 5.94 | 2.39 | 0.98 | 9.31 | 7. | 8 33 | 5. | 9.32 | 10 44 | 10. | 9.40 | 5308 |
| 5281 | Bradley's Corn Phosphate | 0.20 | .... | 2.12 | 2.32 | 2.06 | 6.52 | 6.25 | 3.34 | 1.83 | 11.42 | 10. | 9.59 | 9. | 10.95 | 1.82 | 1.5 | 1.64 | 5281 |
| 5297 | Bradley's Eclipse Phosphate | .... | .... | 1.89 | 1.89 | 1. | 5.29 | 5.32 | 3.79 | 2.24 | 11.35 | 12. | 9.11 | 10. | 10.54 | 1.60 | 1.5 | 1.44 | 5297 |
| 5298 | Bradley's Potato Fertilizer | .... | .... | 2.47 | 2.47 | 2.06 | 6.92 | 6.63 | 2.40 | 2.35 | 11.38 | 11. | 9.03 | 9. | 10.63 | 3 62 | 3.25 | 3.26 | 5298 |
| 5299 | Bradley's Vermonter for all Crops | .... | .... | 2.24 | 2.24 | 2.06 | 6,27 | 6.30 | 2.43 | 2.29 | 11.02 | 10. | 8.73 | 8. | 10.28 | 4.56 | 3.5 | 4.10 | 5299 |
| 5300 | Bradley's XL Superphosphate | .... | 0.12 | 2.43 | 2.55 | 2.5 | 7.18 | 6.39 | 3.72 | 2.40 | 12.51 | 11. | 10.11 | 9. | 11.71 | 1.86 | 2. | 1.67 | 5300 |
| 5225 | Clark's Cove King Philip Alk. Guano | .... | .... | 1.30 | 1.30 | 1.03 | 3.64 | 5.40 | 3.18 | 2.16 | 10.74 | 9. | 8.58 | 8. | 9.98 | 2.00 | 2. | 1.80 | 5225 |
| 5291 | Cleveland Corn and Grain Phosphate | 0.15 | .... | 2.15 | 2.30 | 2.06 | 6.44 | 4.95 | 4.38 | 2.52 | 11 85 | 10.5 | 9.33 | 9.5 | 10.83 | 1.69 | 1.5 | 1.52 | 5291 |
| 5301 | Cleveland Fertilizer for all Crops | .... | .... | 1.25 | 1.25 | 1.03 | 3.50 | 6.63 | 2.11 | 1.66 | 10.40 | 9. | 8.74 | 8. | 10.07 | 2.39 | 2. | 2.15 | 5301 |
| 5285 | Cleveland Potato Phosphate | .... | .... | 2.17 | 2.17 | 2.06 | 6.08 | 6.41 | 3.28 | 1.92 | 11.56 | 10. | 9 64 | 8. | 11.05 | 3 22 | 3. | 2.90 | 5285 |

*Potash in brauds thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | TOTAL. | | AVAILABLE. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| *5304 | Coe's Columbian Corn Fertilizer | .... | .... | 1.44 | **1.44** | *1.2* | $4.08 | 7.48 | 2.76 | 2.54 | **12.78** | *11.* | **10.24** | *9.* | $12.00 | **1.82** | *1.85* | $1.81 | 5304 |
| *5287 | Coe's Columbian Potato Fertilizer | ... | 0.13 | 1.39 | **1.52** | *1.2* | 4.24 | 7.27 | 2.82 | 2.55 | **12.64** | *11.* | **10.09** | *9.* | 11.84 | **1.96** | *1.85* | 1.94 | 5278 |
| 5303 | Crocker's Ammo. Bone Superphos | .... | .... | 2.70 | **2.70** | *2.9* | 7.56 | 8.63 | 2.34 | 0.55 | **11.52** | *11.* | **10.97** | *10.* | 12.05 | **1.39** | *1.08* | 1.25 | 5303 |
| 5302 | Crocker's Ammo. Corn Phosphate | .... | .... | 2.14 | **2.14** | *2.* | 5.99 | 7.49 | 2.97 | 1.68 | **12.14** | *11.* | **10.46** | *10.* | 11.88 | **1.79** | *1.6* | 1.61 | 5302 |
| 5305 | Cumberland Superphosphate | .... | 0.12 | 2.12 | **2.24** | *2.06* | 6.26 | 5.72 | 3.73 | 2.30 | **11.75** | *10.* | **9.45** | *8.* | 10.94 | **1.93** | *2.* | 1.74 | 5305 |
| 5286 | Great Eastern Corn Phosphate | .... | 0.29 | 2.75 | **3.04** | *3.* | 8.48 | 6.96 | 1.60 | 1.39 | **9.95** | *9.* | **8.56** | *8.* | 9.81 | **2.41** | *2.* | 2.17 | 5280 |
| 5293 | Great Eastern General Fertilizer | 0.11 | ... | 0.97 | **1.08** | *0.82* | 3.02 | 6.49 | 1.62 | 1.28 | **9.39** | *9.* | **8.11** | *8.* | 9.27 | **4.13** | *4.* | 3.72 | 5293 |
| 5294 | Great Eastern Grass and Oats Fert. | .... | .... | .... | .... | ... | .... | 6.76 | 4.22 | 2.02 | **13.00** | *12.* | **10.98** | *11.* | 12.46 | **2.12** | *2.* | 1.91 | 5294 |
| 5292 | Great Eastern Potato Manure | .... | .... | 2.13 | **2.13** | *2.06* | 5.96 | 6.39 | 2.07 | 2.14 | **10.60** | *9.* | **8.46** | *8.* | 9.96 | **4.21** | *4.* | 3.79 | 5292 |
| 5290 | Lister's Special Potato Fertilizer | .... | 0.21 | 1.54 | **1.75** | *1.65* | 4.88 | 6.47 | 2.84 | 2.53 | **11.64** | *9.* | **9.31** | *8.* | 10.89 | **3.82** | *3.* | 3.44 | 5290 |
| 5288 | Lister's Success Fertilizer | .... | 0.22 | 1.32 | **1.54** | *1.24* | 4.29 | 7.59 | 3.96 | 2.11 | **13.66** | *11.5* | **11.55** | *9.5* | 13.15 | **2.21** | *2.* | 1.99 | 5288 |
| 5229 | Lowell Bone Fertilizer | .. | .... | 1.80 | **1.80** | *1.65* | 5.04 | 4.89 | 3.08 | 1.96 | **9.38** | *9.* | **7.42** | *8.* | 8.64 | **2.80** | *3.* | 2.52 | 5229 |

* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. Found. | Total. Guaranteed. | Available. Found. | Available. Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| 5306 | P. G. Co.'s Soluble Pacific Guano.... | .... | .... | 2.37 | 2.37 | *2.25* | $6.64 | 6.54 | 2.74 | 1.94 | **11.22** | *10.5* | **9.28** | *8.5* | $10.71 | **1.93** | *2.* | $1.74 | 5306 |
| 5256 | P. & P. Co.'s Plymouth Rock Brand. | 0.32 | .... | 2.35 | 2.67 | *2.47* | 7.48 | 4.38 | 4.09 | 1.45 | **9.92** | *9.* | **8.47** | *8.* | 9.49 | **4.24** | *4.* | 3.82 | 5256 |
| 5257 | P. & P. Co.'s Star Brand Superphos. | .... | .... | 1.91 | 1.91 | *1.64* | 5.35 | 4.19 | 4.62 | 1.32 | **10.13** | *8.* | **8.81** | *7.* | 9.76 | **2.64** | *1.5* | 2.38 | 5257 |
| 5282 | Quinnipiac Corn Manure............ | 0.11 | 0.13 | 2.01 | 2.25 | *2.06* | 6.29 | 5.22 | 3.79 | 2.15 | **11.16** | *10.* | **9.01** | *9.* | 10.39 | **1.77** | *1.5* | 1.59 | 5282 |
| 5289 | Quinnipiac Potato Phosphate.... ... | 0.10 | .... | 2.37 | 2.47 | *2.05* | 6.92 | 6.18 | 2.87 | 2.37 | **11.42** | *9.* | **9.05** | *8.* | 10.62 | **3.64** | *3.* | 3.28 | 5289 |
| 5277 | Standard Fertilizer.... ............ | .... | .... | 2.13 | 2.13 | *2.06* | 5.96 | 5.74 | 3.84 | 1.93 | **11.51** | *10.* | **9.58** | *8.* | 10.93 | **1.92** | *2.* | 1.73 | 5277 |
| 5296 | Tucker's Imperial Bone Superphos .. | .... | .... | 2.16 | 2.16 | *1.* | 6.05 | 4.19 | 4.26 | 2.50 | **10.95** | *11.* | **8.45** | *9.* | 9.87 | **2.07** | *1.85* | 1.86 | 5296 |
| 5310 | Tucker's Imperial for Potatoes ...... | 0.30 | .... | 1.83 | 2.13 | *1.* | 5.96 | 5.13 | 3.88 | 2.14 | **11.15** | *11.* | **9.01** | *9.* | 10.38 | **2.02** | *1.85* | 1.82 | 5310 |
| 5295 | W. & C. Co,'s Americus Corn Phos.. | .... | .... | 2.36 | 2 36 | *2.06* | 6.61 | 6.47 | 2.88 | 2.07 | **11.42** | *10.* | **9.35** | *9.* | 10.88 | **1.65** | *1.5* | 1.48 | 5296 |
| 5284 | W. & Co.'s Ammo. Potato and Tobac | 0.10 | .... | 2.19 | 2.29 | *2.06* | 6.41 | 5.88 | 3.15 | 2.39 | **11.42** | *9.* | **9.03** | *8.* | 10.57 | **3.39** | *3.* | 3.05 | 5284 |
| 5288 | W. & C. Co.'s Royal Bone Phosphate | .... | .... | 1.36 | 1.36 | *1.03* | 3.81 | 5.34 | 3.40 | 1.88 | **10.62** | *8.* | **8.74** | *7.* | 10.03 | **2.25** | *2.* | 2.02 | 5288 |

*Potash in brands thus marked is partly, if not entirely, in form of sulphate ; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

1897.

VERMONT

# AGRICULTURAL EXPERIMENT STATION.

## BULLETIN No. 58.

APRIL, 1897.

## Analyses of Commercial Fertilizers.

I. STATEMENT REGARDING COLLECTION OF SAMPLES.—Pages 35–37.
II. LICENSED FERTILIZERS SAMPLED BY STATION.—Pages 37–39.
III. ANALYSES OF LICENSED FERTILIZERS.—Pages 40–45.
IV. BRANDS NOT REPORTED IN THIS BULLETIN.—Pages 46–47.

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1897.

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN No. 58.

# ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills, B. O. White and C. H. Jones.

## I. STATEMENT REGARDING COLLECTION OF SAMPLES.

During February, March and early April, Messrs. C. F. Clark of Glover, W. C. Perry of Burlington, D. H. Udall of Craftsbury, and A. M. Vaughan of Woodstock, agents of this Station, visited 104 towns and villages in Vermont and drew 386 samples, representing 119 distinct brands of fertilizers. One hundred and ten brands were found last year, 92 in 1895, 53 in 1894, and but 36 in 1893. This rapid increase is due to an actual increase in the number of brands sold, to an increase in the number of companies licensed and to our inability to make a thorough search prior to 1895.

It is believed that one or more samples of nearly every brand of fertilizer sold in the State have been secured this spring. The Station desires that farmers, farmers' clubs and granges call its attention to brands of fertilizer on sale not included in this bulletin, either in the tables of analyses or the list of samples on hand. So far as is practicable goods thus reported will be sampled. It should be noted, however, that, as a rule, the Station will not sample or analyze:

1. From stock of less than one ton.
2. From stock which has lain over from a former season.
3. From stock which has been improperly stored.

Bulletin 57, distributed to the state mailing list March 27th, contained analyses of composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the State) of leading brands of goods made by each manufacturer then licensed to sell in this State, except the Read Fertilizer Co. and the Russia Cement Co., none of whose goods had at that time been found by us. The present bulletin contains the analyses of composite samples of 66 distinct brands, the output of nineteen manufacturers. The analysis of a composite sample certainly represents the average character of the goods more fairly than can the analysis of a single sample. The 35 analyses published in Bulletin 57 are reprinted to facilitate ready reference.

The 66 brands reported comprise all those of which three or more samples were found by the Station agents. There is reason to believe that fully nine-tenths of the trade in the State is confined to these brands.

The reader is referred to Bulletin 57 for details regarding the schedule of trade values and their application to superphosphates and mixed goods. The values per pound of the ingredients as found in mixed goods are as follows: organic and nitrate nitrogen, 14 cents; nitrogen from ammonia salts, 13½ cents; soluble, reverted and insoluble phosphoric acids, 5½, 5 and 2 cents respectively; potash, as sulphate, 5 cents, as muriate, 4¼ cents. It should be particularly noted, however, that **these trade values do not represent the proper selling prices of mixed goods at the point of consumption,** but are the retail trade values or cash-cost of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in standard unmixed raw materials of good quality, at the seaboard. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have an almost purely commercial significance.

The reader is also referred to Bulletins 47 and 52 for a full discussion of the principles and practice of fertilization, with suggestions concerning the selection, purchase and use of artificial fertilizers, and especially to the remarks on home mixing. These as well as other bulletins and reports will be sent to any address without charge, on application.

### OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however, that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the State" are not affected by the restrictions of the law.

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | 92 State St., Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | 92 State St., Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co. | State St. and Merchants Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133-137 Front St., New York, N. Y. |

11 Williams & Clark Fertilizer Co......27 William St., New York, N. Y.
12 Great Eastern Fertilizer Co............ ...............Rutland, Vt.
13 Clark's Cove Fertilizer Co...Farlow Building, State St., Boston Mass.
14 Henry F. Tucker Co........ Farlow Building, State St., Boston, Mass.
15 Read Fertilizer Co.......................Box 3121, New York, N. Y.
16 Lowell Fertilizer Co..............44 North Market St., Boston, Mass.
18 Parmenter and Polsey Co...........................Peabody, Mass.
19 Russia Cement Co.......................... ....Gloucester, Mass.
20 American Fertilizer Co..................153 Milk St., Boston, Mass.

## II. LICENSED FERTILIZERS SAMPLED BY STATION.*

### American Fertilizer Co., Boston, Mass.

**5473. Alkali Nitrate Phosphate**; from stock of Mellen & Proctor, Brattleboro.

### Bowker Fertilizer Co., Boston, Mass.

**5495. Potash Phosphate**; from stocks of D. L. Wilkins, West Windsor; N. D. House, Waitsfield; E. D. Shepardson, Fairfax.

**5506. Potato and Vegetable Phosphate**; from stock of G. H. Robertson, South Shaftsbury; C. L. French, Hardwick; G. A. Wales, South Barre.

**5505. Sure Crop Phosphate**; from stocks of A. E. Fuller, Woodstock; D. L. Wilkins, West Windsor; C. G. and H. F. Leach, North Rupert.

**5494. Vermont Phosphate**; from stocks of N. D. House, Waitsfield; E. D. Shepardson, Fairfax; D. L. Wilkins, West Windsor.

### Bradley Fertilizer Co., Boston, Mass.

**5481. Complete Manure for Top Dressing Grass and Grain**; from stocks of M. G. Armstrong, Norwich; H. W. Sumner, Corinth; L. D. Nute, Marshfield.

**5311. Patent Superphosphate of Lime**; from stocks of L. D. Nute, Marshfield; Burt Bros., Enosburgh Falls; G. H. Tupper, Bethel.

**5482. Potato Manure**: from stocks of M. G. Armstrong, Norwich; H. B. Chamberlain, Bradford; O. Upston, West Windsor.

### Clark's Cove Fertilizer Co., Boston, Mass.

**5497. Bay State Fertilizer, G. G.**; from stocks of Knight & Walker, West Brattleboro; L. O. Brush, Underhill; J. H. Silsby, Lunenburgh.

### Cleveland Dryer Co., Boston, Mass.

**5492. Superphosphate**; from stocks of D. A. Spooner, Randolph; Dutton & Richmond, Northfield: R. D. Stuart, Berlin.

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*The names and locations of agents from whom samples were taken which made analytical samples reported in Bulletin 57 and reprinted in this bulletin may be found on reference thereto.

### E. Frank Coe Co., New York, N. Y.

**5504. Celebrated Grass and Grain Fertilizer**; from stocks of W. W. Brownten, Poultney; E. B. Whipple, Westford; J. Duffee, Cambridge.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**5484. New Rival Ammoniated Bone Superphosphate**; from stocks of C. C. Fisher, Wolcott; H. W. Rice, Westford; J. B. Brock, West Newbury; Isaiah Benson, West Woodstock; A. R. Foote, East Middlebury.

**5485. Potato, Hop and Tobacco Phosphate**; from stocks of C. C. Fisher, Wolcott; H. W. Rice, Westford; J. B. Brock, West Newbury; Fred Fuller, Montpelier; A. R. Foote, East Middlebury.

**5489. Superior Rye and Oats Fertilizer**; from stocks of Isaiah Benson, West Woodstock; F. A. Ward, Middlesex; Beecher Bros., West Pawlet.

### Cumberland Bone Phosphate Co., Boston, Mass.

**5487. Guano**; from stocks of Chas. Gates & Sons, North Hartland; W. H. Nye, Johnson; W. F. Clark, Glover.

**5486. Potato Fertilizer**; from stocks of H. N. Stanhope, Richford; W. F. Clark, Glover; W. H. Nye, Johnson; E. B. Moody, Waterbury Center.

**5508. Seeding Down Manure**; from stocks of F. H. Frazier, West Burke; Jordan Bros., Jericho Center; W. H. Nye, Johnson.

### Lister's Agricultural Chemical Works, Newark, N. J.

**5493. Animal Bone and Potash**; from stocks of H. E. Lamphier Hyde Park; C. L. Hodges, Randolph; J. W. Egan, Middlesex.

### Lowell Fertilizer Co., Boston, Mass.

**5507. Swift's Lowell Empire Brand**; from stocks of A. M. Heath, Groton; F. Bliss, Georgia; E. T. Ryder, Morrisville; C. D. Loukes, Highgate.

### Pacific Guano Co. Boston, Mass.

**5483. Special for Potatoes and Tobacco**; from stocks of W. F. Clark, Glover; V. Higley, Richmond; R. B. Pixley, Norwich; A. T. Smith, West Topsham.

### Quinnipiac Co., Boston, Mass.

**5491. Climax Phosphate**; from stocks of Joel Avery, South Corinth; G. D. Butler, Montpelier; J. A. Smith, Waitsfield.

### Read Fertilizer Co., New York, N. Y.

**5501. Farmer's Friend Superphosphate**; from stocks of B. T. Way, Peacham; J. P. Webster, Lyndonville; J. B. Pursey, Bennington.

**5503. Fish, Bone and Potash**; from stocks of J. B. Pursey, Bennington; A. J. Lyon, West Concord; V. A. Patch, Johnson; W. S. Russell, East St. Johnsbury; M. A. Hoadley, Waterbury.

**5502. Leader Guano**; from stocks of M. A. Hoadley, Waterbury; A. J. Lyon, West Concord; W. S. Russell, East St. Johnsbury; Perry Porter, West Burke; J. B. Pursey, Bennington.

**5499. Practical Potato Special**; from stocks of W. S. Russell, East St. Johnsbury; E. E. Sprague, East Montpelier; Gove & Taylor, Burlington; J. B. Pursey, Bennington.

**5488. Standard Superphosphate**; from stocks of M. A. Hoadley, Waterbury; E. E. Sprague, East Montpelier; V. A. Patch, Johnson.

**5500. Sure Catch Fertilizer**; from stocks of W. S. Russell, East St. Johnsbury; Perry Porter, West Burke; W. S. Russell, Barton.

### Russia Cement Co., Gloucester, Mass.

**5498. Essex Complete Manure for Corn, Grain and Grass**; from stocks of C. F. Eddy, Waitsfield; E. S. Ruggles, Windsor; R. C. Martin, Bradford.

**5490. Essex XXX Fish and Potash**; from stocks of C. F. Eddy, Waitsfield; J. L. Slocum, Berlin; J. Russell, Castleton; B. A. Hunt, Johnson.

### Henry F. Tucker Co., Boston, Mass.

**5509. Imperial Bone Superphosphate for Corn**; from stocks of I. E. Huntley, Westford; L. H. Warren, Hardwick; F. J. Libby, Newport.

### Williams & Clark Fertilizer Co., New York, N. Y.

**5496. Americus Ammoniated Bone Superphosphate**; from stocks of M. V. Willard, Jericho Center; Webster & Frazier, East Burke; Edward Whitcomb, Essex Junction.

## III. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| *5473 | American Fert. Co. Alk. Nit. Phos. | 2.90 | .... | ... | **2.90** | *3.25* | $8.12 | 0.07 | 12.25 | 7.14 | **19.46** | .... | **12.32** | *11.* | $15.19 | **4.01** | *4.* | $3.86 | 5473 |
| †5309 | Bowker's Hill and Drill Phosphate | 0.81 | .... | 1.61 | **2.42** | *2.5* | 6.78 | 9.00 | 3.03 | 1.70 | **13.73** | *12.* | **12.03** | *9.* | 13.61 | **2.39** | *2.* | 2.15 | 5309 |
| 5495 | Bowker's Potash Phosphate | 0.27 | .... | 0.67 | **0.94** | *0.75* | 2.63 | 1.41 | 6.77 | 4.63 | **12.81** | *10.* | **8.18** | *8.* | 10.17 | **3.50** | *3.* | 3.15 | 5495 |
| 5506 | Bowker's Potato and Veg. Phos | 0.77 | .... | 1.00 | **1.77** | *1.5* | 4.96 | 3.82 | 4.60 | 3.76 | **12.18** | *10.* | **8.42** | *8.* | 10.31 | **2.09** | *2.* | 1.88 | 5506 |
| †5307 | Bowker's Stockbridge Corn Manure | 1.24 | .... | 2.08 | **3.32** | *3.25* | 9.30 | 6.69 | 2.75 | 1.80 | **11.24** | *10.* | **9.44** | *8.* | 10.83 | **7.39** | *6.* | 6.65 | 5307 |
| †5308 | Bowker's Stockbridge Potato Manure | 1.50 | .... | 1.90 | **3.40** | *3.* | 9.52 | 5.94 | 2.39 | 0.98 | **9.31** | *7.* | **8.33** | *5.* | 9.32 | **10.44** | *10.* | 9.40 | 5308 |
| 5505 | Bowker's Sure Crop Phosphate | 0.26 | .... | 0.80 | **1.06** | *0.75* | 2.97 | 4.99 | 4.55 | 2.68 | **12.22** | *10.* | **9.54** | *8.* | 11.11 | **1.46** | *1.* | 1.81 | 5505 |
| 5494 | Bowker's Vermont Phosphate | 0.62 | .... | 1.43 | **2.05** | *1.75* | 5.74 | 4.20 | 4.01 | 3.32 | **11.53** | *10.* | **8.21** | *8.* | 9.96 | **3.32** | *3.* | 2.99 | 5494 |
| *5481 | Bradley's Complete Top Dressing | 4.78 | .... | 0.63 | **5.41** | *4.95* | 15.15 | 1.49 | 3.75 | 1.20 | **6.44** | *6.* | **5.24** | *5.* | 5.87 | **3.05** | *2.5* | 2.88 | 5481 |
| †5281 | Bradley's Corn Phosphate | 0.20 | .... | 2.12 | **2.32** | *2.06* | 6.50 | 6.25 | 3.34 | 1.83 | **11.42** | *10.* | **9.59** | *9.* | 10.95 | **1.82** | *1.5* | 1.64 | 5281 |
| †5297 | Bradley's Eclipse Phosphate | .... | .... | 1.89 | **1.89** | *1.* | 5.29 | 5.32 | 3.79 | 2.24 | **11.35** | *12.* | **9.11** | *10.* | 10.54 | **1.60** | *1.5* | 1.44 | 5297 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. †Reprinted from Bulletin 57.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. | | Available. | | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| | | | | | | | | | | | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| 5311 | Bradley's Patent Superphosphate | .... | .... | 2.37 | 2.37 | *2.05* | $6.64 | 6.24 | 4.11 | 2.04 | 12.39 | *11.* | 10.35 | *9.* | $11.79 | 1.82 | *2.* | $1.64 | 5311 |
| †5298 | Bradley's Potato Fertilizer | .... | .... | 2.47 | 2.47 | *2.06* | 6.92 | 6.63 | 2.40 | 2.35 | 11.38 | *11.* | 9.03 | *9.* | 10.68 | 3.62 | *3.25* | 3.26 | 5298 |
| 5482 | Bradley's Potato Manure | 0.27 | .... | 2.20 | 2.47 | *2.5* | 6.92 | 4.29 | 2.15 | 2.81 | 8.75 | *8.* | 6.44 | *6.* | 7.79 | 5.38 | *5.* | 4.84 | 5482 |
| †5299 | Bradley's Vermonter for all Crops | .... | .... | 2.24 | 2.24 | *2.06* | 6.27 | 6.30 | 2.43 | 2.29 | 11.02 | *10.* | 8.73 | *8.* | 10.28 | 4.56 | *3.5* | 4.10 | 5299 |
| †5300 | Bradley's XL Superphosphate | .... | 0.12 | 2.43 | 2.55 | *2.5* | 7.13 | 6.39 | 3.72 | 2.40 | 12.51 | *11.* | 10.11 | *9.* | 11.71 | 1.86 | *2.* | 1.67 | 5300 |
| 5497 | Clark's Cove Bay State Fert. G. G. | .... | .... | 2.20 | 2.20 | *1.85* | 6.16 | 4.90 | 4.36 | 2.36 | 11.62 | *10.* | 9.26 | *8.5* | 10.69 | 2.06 | *2.* | 1.85 | 5497 |
| †5225 | Clark's Cove King Philip Alk. Guano | .... | .... | 1.30 | 1.30 | *1.03* | 3.64 | 5.40 | 3.18 | 2.16 | 10.74 | *9.* | 8.58 | *8.* | 9.98 | 2.00 | *2.* | 1.80 | 5225 |
| †5291 | Cleveland Corn and Grain Phosphate | 0.15 | .... | 2.15 | 2.30 | *2.06* | 6.44 | 4.95 | 4.38 | 2.52 | 11.85 | *10.5* | 9.33 | *9.5* | 10.83 | 1.69 | *1.5* | 1.52 | 5291 |
| †5301 | Cleveland Fertilizer for all Crops | .... | .... | 1.25 | 1.25 | *1.03* | 3.50 | 6.63 | 2.11 | 1.66 | 10.40 | *9.* | 8.74 | *8.* | 10.07 | 2.39 | *2.* | 2.15 | 5301 |
| †5285 | Cleveland Potato Phosphate | .... | .... | 2.17 | 2.17 | *2.06* | 6.08 | 6.41 | 3.23 | 1.92 | 11.56 | *10.* | 9.64 | *8.* | 11.05 | 3.22 | *3.* | 2.90 | 5285 |
| 5492 | Cleveland Superphosphate | .... | .... | 2.15 | 2.15 | *2.05* | 6.02 | 5.55 | 3.60 | 2.22 | 11.37 | *11.* | 9.15 | *9.* | 10.59 | 2.00 | *2.* | 1.80 | 5492 |

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## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. |  |  |  |  |  | PHOSPHORIC ACID. |  |  |  |  |  |  |  | POTASH. |  |  | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  | Total. |  | Available. |  |  |  |  |  |  |
|  |  | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. |  |
| *5504 | Coe's Celebrated Grass and Grain.. | .... | .... | 1.08 | **1.08** | *0.8* | $3.02 | 7.10 | 3.74 | 3.04 | **13.88** | *10.* | **10.84** | *9.* | $12.77 | **1.59** | *1.35* | $1.47 | 5504 |
| *†5304 | Coe's Columbian Corn Fertilizer... | .... | .... | 1.44 | **1.44** | *1.2* | 4.03 | 7.48 | 2.76 | 2.54 | **12.78** | *11.* | **10.24** | *9.* | 12.00 | **1.82** | *1.85* | 1.81 | 5304 |
| *†5287 | Coe's Columbian Potato Fertilizer | ... | 0.13 | 1.39 | **1.52** | *1.2* | 4.24 | 7.27 | 2.82 | 2.55 | **12.64** | *11.* | **10.09** | *9.* | 11.84 | **1.96** | *1.85* | 1.94 | 5287 |
| †5303 | Crocker's Ammo. Bone Superphos | .... | .... | 2.70 | **2.70** | *2.9* | 7.56 | 8.63 | 2.34 | 0.55 | **11.52** | *11.* | **10.97** | *10.* | 12.05 | **1.39** | *1.08* | 1.25 | 5303 |
| †5302 | Crocker's Ammo. Corn Phosphate | .... | .... | 2.14 | **2.14** | *2.* | 5.99 | 7.49 | 2.97 | 1.68 | **12.14** | *11.* | **10.46** | *10.* | 11.88 | **1.79** | *1.6* | 1.61 | 5302 |
| 5484 | Crocker's New Rival Ammo. Bone. | .... | ... | 1.35 | **1.35** | *1.23* | 3.78 | 7.52 | 2.75 | 1.14 | **11.41** | *11.* | **10.27** | *10.* | 11.48 | **1.92** | *1.6* | 1.73 | 5484 |
| 5485 | Crocker's Potato, Hop and Tobacco | .... | .... | 2.22 | **2.22** | *2.* | 6.22 | 8.34 | 2.67 | 0.65 | **11.66** | *11.* | **11.01** | *10.* | 12.10 | **3.56** | *3.25* | 3.20 | 5485 |
| 5489 | Crocker's Superior Rye and Oats. | .... | .... | 1.06 | **1.06** | *0.82* | 2.97 | 6.61 | 2.48 | 1.43 | **10.52** | *9.* | **9.09** | *8.* | 10.32 | **1 94** | *2.* | 1.75 | 5489 |
| 5487 | Cumberland Guano .............. | .... | .... | 1.33 | **1.33** | *1.03* | 3.72 | 5.36 | 3.76 | 1.79 | **10.91** | *10.* | **9.12** | *8.* | 10.37 | **2 12** | *2.* | 1.91 | 5487 |
| 5486 | Cumberland Potato Fertilizer.... | 0.19 | .... | 2.05 | **2.24** | *2.06* | 6.27 | 5.60 | 3.51 | 2.92 | **12.03** | *11.* | **9.11** | *9.* | 10.84 | **3·30** | *3.* | 2.97 | 5486 |
| 5508 | Cumberland Seeding Down...... | .... | .... | 1.29 | **1.29** | *1.03* | 3.61 | 5.49 | 3.08 | 2.04 | **10 56** | *10.* | **8.52** | *8.* | 9.89 | **2.00** | *2.* | 1.80 | 5508 |

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## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. | | Available. | | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| | | | | | | | | | | | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| †5305 | Cumberland Superphosphate | ---- | 0.12 | 2.12 | **2.24** | *2.06* | $6.26 | 5.72 | 3.73 | 2.30 | **11.75** | *10.* | **9.45** | *8.* | $10.94 | **1.93** | *2.* | $1.74 | 5305 |
| †5286 | Great Eastern Corn Phosphate | ---- | 0.29 | 2.75 | **3.04** | *3.* | 8.48 | 6.96 | 1.60 | 1.39 | **9.95** | *9.* | **8.56** | *8.* | 9.81 | **2.41** | *2.* | 2.17 | 5280 |
| †5293 | Great Eastern General Fertilizer | 0.11 | ---- | 0.97 | **1.08** | *0.82* | 3.02 | 6.49 | 1.62 | 1.28 | **9.39** | *9.* | **8.11** | *8.* | 9.27 | **4.13** | *4.* | 3.72 | 5293 |
| †5294 | Great Eastern Grass and Oats Fert. | ---- | ---- | ---- | ---- | --- | ---- | 6.76 | 4.22 | 2.02 | **13.00** | *12.* | **10.98** | *11.* | 12.46 | **2.12** | *2.* | 1.91 | 5294 |
| †5292 | Great Eastern Potato Manure | ---- | ---- | 2.13 | **2.13** | *2.06* | 5.96 | 6.39 | 2.07 | 2.14 | **10.60** | *9.* | **8.46** | *8.* | 9.96 | **4.21** | *4.* | 3.79 | 5292 |
| 5493 | Lister's Animal Bone and Potash | ---- | --- | ---- | ---- | --- | ---- | 6.62 | 2.84 | 0.94 | **10.40** | *10.* | **9.46** | *9.* | 10.50 | **5.12** | *5.* | 4.61 | 5493 |
| †5290 | Lister's Special Potato Fertilizer | ---- | 0.21 | 1.54 | **1.75** | *1.65* | 4.88 | 6.47 | 2.84 | 2.53 | **11.64** | *9.* | **9.31** | *8.* | 10.89 | **3.82** | *3.* | 3.44 | 5290 |
| †5283 | Lister's Success Fertilizer | ---- | 0.22 | 1.32 | **1.54** | *1.24* | 4.29 | 7.59 | 3.96 | 2.11 | **13.66** | *11.5* | **11.55** | *9.5* | 13.15 | **2.21** | *2.* | 1.99 | 5283 |
| †5229 | Lowell Bone Fertilizer | ---- | ---- | 1.80 | **1.80** | *1.65* | 5.04 | 4.39 | 3.03 | 1.96 | **9.38** | *9.* | **7.42** | *8.* | 8.64 | **2.80** | *3.* | 2.52 | 5229 |
| 5507 | Lowell Empire Brand | --- | ---- | 1.29 | **1.29** | *1.23* | 3.61 | 2.89 | 3.94 | 1.86 | **7.69** | *8.* | **6.83** | *7.* | 7.86 | **2.46** | *2.* | 2.21 | 5507 |
| †5306 | P. G. Co.'s Soluble Pacific Guano | ---- | ---- | 2.37 | **2.37** | *2.25* | 6.64 | 6.54 | 2.74 | 1.94 | **11.22** | *10.5* | **9.28** | *8.5* | 10.71 | **1.93** | *2.* | 1.74 | 5306 |

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## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| 5483 | P. G. Co.'s Spcl. Potato and Tobacco | 0.17 | .... | 2.03 | **2.20** | *2.06* | $6.16 | 5.64 | 3.25 | 2.66 | **11.55** | *9.* | **8.89** | *8.* | $10.52 | **3 34** | *3.* | $3.01 | 5483 |
| †5256 | P. & P. Co.'s Plymouth Rock Brand | 0.32 | .... | 2.35 | **2.67** | *2.47* | 7.48 | 4.38 | 4.09 | 1.45 | **9.92** | *9.* | **8.47** | *8.* | 9.49 | **4.24** | *4.* | 3.82 | 5256 |
| †5257 | P. & P. Co.'s Star Brand Superphos | .... | .... | 1.91 | **1.91** | *1.64* | 5.35 | 4.19 | 4.62 | 1.32 | **10.13** | *8.* | **8.81** | 7. | 9.76 | **2.64** | *1.5* | 2.38 | 5257 |
| 5491 | Quinnipiac Climax Phosphate | .... | .... | 1.29 | **1.29** | *1.03* | 3.61 | 5.40 | 2.98 | 1.72 | **10.10** | *9.* | **8.38** | *8.* | 9.61 | **2.23** | *2.* | 2.01 | 5491 |
| †5282 | Quinnipiac Corn Manure | 0.11 | 0.13 | 2.01 | **2.25** | *2.06* | 6.29 | 5.22 | 3.79 | 2.15 | **11.16** | *10.* | **9.01** | *9.* | 10.89 | **1.77** | *1.5* | 1.59 | 5282 |
| †5289 | Quinnipiac Potato Phosphate | 0.10 | .... | 2.37 | **2.47** | *2.05* | 6.92 | 6.18 | 2.87 | 2.37 | **11.42** | *9.* | **9.05** | *8.* | 10.62 | **3.64** | *3.* | 3.28 | 5289 |
| 5501 | Read's Farmers' Friend Superphos | .... | ... | 2.25 | **2.25** | *2.06* | 6.30 | 6.97 | 2.67 | 1.02 | **10.66** | *10.* | **9.64** | *9.* | 10.75 | **2.27** | *2.* | 2.04 | 5501 |
| 5503 | Read's Fish, Bone and Potash | .... | 0.26 | 2.48 | **2.74** | *2.47* | 7.64 | 3.11 | 1.36 | 1.09 | **5.56** | *5.* | **4.47** | *4.* | 5.22 | **4.50** | *4.* | 4.04 | 5503 |
| 5502 | Read's Leader Guano | .... | .... | 1.10 | **1.10** | *0.82* | 3.08 | 5.50 | 1.96 | 0.95 | **8.41** | *8.* | **7.46** | 7. | 8.89 | **2.73** | *2.* | 2.46 | 5502 |
| 5499 | Read's Practical Potato Special | .... | .... | 1.09 | **1.09** | *0.82* | 3.05 | 2.51 | 1.98 | 1.81 | **5.80** | *5.* | **4.49** | *4.* | 5.27 | **8.29** | *8.* | 7.46 | 5499 |
| 5488 | Read's Standard Superphosphate | .... | .... | 1.15 | **1.15** | *0.82* | 3.22 | 6.14 | 2.09 | 1.11 | **9.34** | *9.* | **8.23** | *8.* | 9.29 | **3.36** | *4.* | 8.02 | 5488 |

* Potash in brands thus marked is largely if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. †Reprinted from Bulletin 57.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. | | Available. | | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| | | | | | | | | | | | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| 5500 | Read's Sure Catch Fertilizer | .... | .... | .... | .... | -- - | $--- | 5.45 | 2.30 | 0.86 | 8.61 | 7. | 7.75 | 6. | $8.64 | 5.14 | 4. | $4.63 | 5500 |
| 5498 | R. C. Co.'s Essex Complete Corn, &c. | 0.94 | .... | 3.13 | 4.07 | 3.7 | 11.40 | 3.51 | 5.56 | 2.61 | 11.68 | 9.5 | 9.07 | 7. | 10.47 | 9.88 | 9.5 | 8.8 | 5498 |
| 5490 | R. C. Co.'s Essex XXX Fish & Pot. | .... | .... | 2.65 | 2.65 | 2.1 | 7.42 | 4.02 | 5.89 | 3.81 | 13.72 | 10. | 9.91 | 10. | 11.84 | 2.55 | 2.25 | 2.29 | 5490 |
| †5277 | Standard Fertilizer | .... | .... | 2.13 | 2.13 | 2.06 | 5.96 | 5.74 | 3.84 | 1.93 | 11.51 | 10. | 9.58 | 8. | 10.93 | 1.92 | 2. | 1.73 | 5277 |
| †5296 | Tucker's Imperial Bone Superphos | ... | .... | 2.16 | 2.16 | 1. | 6.05 | 4.19 | 4.26 | 2.50 | 10.95 | 11. | 8.45 | 9. | 9.87 | 2.07 | 1.85 | 1.86 | 5296 |
| 5509 | Tucker's Imperial for Corn | .... | ... | 2.12 | 2.12 | 1. | 5.94 | 4.79 | 4.18 | 2.43 | 11.40 | 11. | 8.97 | 9. | 10.42 | 1.92 | 1.85 | 1.73 | 5509 |
| †5310 | Tucker's Imperial for Potatoes | 0.30 | .... | 1.83 | 2.13 | 1. | 5.96 | 5.13 | 3.88 | 2.14 | 11.15 | 11. | 9.01 | 9. | 10.38 | 2.02 | 1.85 | 1.82 | 5310 |
| 5496 | W. & C. Co.'s Amer. Ammo. Bone | .... | .... | 2.55 | 2.55 | 2.47 | 7.14 | 6.51 | 3.66 | 2.28 | 12.45 | 10. | 10.17 | 9. | 11.73 | 1.82 | 2. | 1.64 | 5496 |
| †5295 | W. & C. Co,'s Americus Corn Phos. | .... | .... | 2.36 | 2.36 | 2.06 | 6.61 | 6.47 | 2.88 | 2.07 | 11.42 | 10. | 9.35 | 9. | 10.83 | 1.65 | 1.5 | 1.48 | 5295 |
| †5284 | W. & C.Co.'s Ammo.Potato and Tob | 0.10 | .... | 2.19 | 2.29 | 2.06 | 6.41 | 5.88 | 3.15 | 2.39 | 11.42 | 9. | 9.03 | 8. | 10.57 | 3.39 | 3. | 3.05 | 5284 |
| †5288 | W. & C.Co.'s Royal Bone Phosphate | .... | .... | 1.36 | 1.36 | 1.03 | 3.81 | 5.34 | 3.40 | 1.88 | 10.62 | 8. | 8.74 | 7. | 10.03 | 2.25 | 2. | 2.02 | 5288 |

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## IV. BRANDS NOT REPORTED IN THIS BULLETIN.

Samples of the following brands are in the laboratory and their analyses will be published on completion in Bulletin 59. In no case have more than two samples of each of these brands been found by the Station agents.

### BOWKER FERTILIZER Co., Boston, Mass.

Ammoniated Corn Phosphate.
Farm and Garden Phosphate.
Market Garden Fertilizer.
Potash Bone.
Potato and Vegetable Manure.
Square Brand Bone and Potash.
Stockbridge Manure for Onions,
Stockbridge Manure for Seeding Down.
Stockbridge Manure for Top Dressing.
Vermont Grange Chemicals, D Brand.

### BRADLEY FERTILIZER Co., Boston, Mass.

B. D. Sea Fowl Guano.
Complete Manure for Corn and Grain.
Complete Manure for Potatoes and Vegetables.
Original Coe's Superphosphate of Lime.
Seeding Down Manure.

### CLARK'S COVE FERTILIZER Co., Boston, Mass.

Potato and Tobacco Fertilizer.

### CLEVELAND DRYER Co., Boston, Mass.

High Grade Complete Manure.
Pioneer Fertilizer.
Seeding Down Manure.
Special for Wheat, Rye and Oats.

### E. FRANK COE Co., New York, N. Y.

Bay State Imperial Superphosphate.
Celebrated Special Potato Fertilizer.
Columbian Ammoniated Bone Superphosphate.
Dissolved Bone and Potash.
Excelsior Potato Fertilizer.
Gold Brand Excelsior Guano.
High Grade Ammoniated Bone Superphosphate.
Red Brand Excelsior Guano.
Standard Grade Ammoniated Bone Superphosphate.
XXV Superphosphate.

### CROCKER FERTILIZER AND CHEMICAL CO., Buffalo, N. Y.

Special Potato Manure.

### CUMBERLAND BONE PHOSPHATE CO., Boston, Mass.

Fertilizer.

### LISTER'S AGRICULTURAL CHEMICAL WORKS, Newark, N J.

Animal Bone and Potash No. 2.
Harvest Queen Phosphate.
Perfect Fertilizer.
Potato Manure No. 1.
United States Superphosphate.

### LOWELL FERTILIZER CO., Boston, Mass.

Animal Brand.
Bone and Potash.
Complete Manure for Vegetables.

### PACIFIC GUANO CO., Boston, Mass.

Nobsque Guano.

### QUINNIPIAC CO., Boston, Mass.

Market Garden Manure.
Pine Island Phosphate.
Potato Manure.
Seeding Down Fertilizer.

### READ FERTILIZER CO., New York, N. Y.

Prime Wheat and Rye Fertilizer.

### RUSSIA CEMENT CO., Gloucester, Mass.

Complete Manure for Potatoes, Roots and Vegetables.
High Grade Superphosphate.

### STANDARD FERTILIZER CO., Boston, Mass.

Guano.
Potato and Tobacco Fertilizer.
Superphosphate.

### WILLIAMS & CLARK FERTILIZER CO., New York, N. Y.

Americus Potato Phosphate.
High Grade Special.

# 1897.

# VERMONT

# AGRICULTURAL EXPERIMENT STATION.

# BULLETIN No. 59.

MAY, 1897.

## Analyses of Commercial Fertilizers.

I. **Summary of Bulletins 57, 58 and 59—Page 51.**
II. **Results of Inspection—Pages 52-59.**
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1897.

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 59.

## ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills, B. O. White and C. H. Jones.

### I. SUMMARY.

II. Trade values per pound of fertilizing ingredients in mixed goods: nitrogen in nitrates, ammonia salts, and in organic forms, 14, 13 1-2 and 14 cents; soluble, reverted and insoluble phosphoric acids, 5 1-2, 5 and 2 cents; potash, sulphate and muriate, 5 and 4 1-2 cents. The "station valuation" does not represent the proper selling price in Vermont, but shows the retail cash-cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. Its significance is not agricultural but is almost purely commercial. (Bul. 57, pp. 20-24.)

II. and IV. The Station has analyzed samples of 134 distinct brands, the output of 20 companies, all drawn from dealers' stocks and (with one exception) this year's goods. The number of brands sold in the State is rapidly increasing. Two-thirds of the total number were above guarantee in every respect and five-sixths were essentially equal to or better than guarantee. Sixteen brands fell short more than 0.20 per cent. in one, five were lacking in two ingredients and one was below guarantee throughout. In one of the five cases both ingredients were seriously deficient. Shortages in one ingredient were not made good (commercially) by excess of other ingredients in seven brands, a part of the output of three companies. In one case analysis and guarantee were found to be widely apart in two ingredients, although an equivalent of plant food was given. Ninety-four per cent. of the entire number of brands contained the commercial equivalent of their guarantees. One hundred and two brands were guaranteed (directly or inferentially) to contain potash as sulphate, a claim which was verified in but 17 cases. The application of pepsin digestion and Hayes-permanganate distillation methods to the several brands indicated that the class of materials furnishing organic nitrogen was almost without exception above reproach.

The average "valuation" was $19.47 and the average selling price $29.19, an advance of 50 per cent. over valuation. One dollar out of every three invested in fertilizers paid for cost of manufacture and sale. A dollar spent for average low priced goods (below $29) bought 64 cents worth of plant food; a dollar invested in average medium grade brands ($29 to $35), 69 cents worth; and a dollar paid out for average high priced goods ($35 and upwards), 72 cents worth. (Pages 52-75).

V. The average composition of the goods has not varied materially from that of last year. Selling prices are lower and plant food cheaper than ever before in the history of the trade. (Pages 76-77.)

## II. RESULTS OF INSPECTION.

*Collection of Samples.*—The sampling agents of the station visited 113 towns and villages in Vermont during the spring of 1897, and drew 417 samples from dealers' stocks, representing 134 distinct brands, the output of twenty* companies licensed to sell in Vermont. It is thought that every brand sold in the State this spring, with one exception, has been sampled and analyzed. One hundred and ten brands were found in 1896, 92 in 1895, 53 in 1894, and but 36 in 1893. This rapid increase is mainly due to the larger trade in commercial fertilizers in recent years, which, according to the statistics taken by this Station in 1896,† approximates 13,000 tons yearly.

*Bulletins 57, 58 and 59.*—Section 4355 of the Vermont Statutes makes it the duty of the director of the Station to have "one analysis . . . of each fertilizer . . . made annually and the result published monthly." The early shipments made into this State enable the Station to analyze and publish in March, April and May. The analyses of the brands which seem to be in most common use are printed in the March and April bulletins, thus becoming available as an aid in choice for purchase.

Bulletin 57, distributed to the state mailing list March 27th, contained 35 analyses made upon composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the State) of leading brands of goods made by seventeen manufacturers. Bulletin 58, distributed to the State mailing list April 23rd, contained the analyses of composite samples of 66 brands, the output of nineteen manufacturers.

The brands reported in Bulletins 57 and 58 comprise all those of which three or more samples were found by the Station agents. There is reason to believe that fully nine-tenths of the trade in the State is confined to these brands. These analyses, with sixty-five more, are grouped alphabetically by manufacturers' names in this bulletin. A few samples drawn after the tables were set up are placed out of order on page 75.

*Guarantees and Analyses.—Nearly two-thirds* (86 out of 134) of the brands analyzed proved to be above guarantee in nitrogen, in available phosphoric acid and in potash. Twenty-seven of the forty-eight brands found deficient were short less than 0.20 per cent. in a single ingredient, so that practically *five-sixths of the brands sold this year in Vermont proved to be equal to or better than their guarantees.* But five brands proved deficient in two ingredients. The entire shortage was less than 0.20 per cent. in one case and it was but 0.09 and 0.20 per cent. in one of the two ingredients in two other cases. One brand, a so-called "Dissolved Bone and Potash," in which no nitrogen was guaranteed, was decidedly deficient in both ingredients. One brand, new in this State, and thus far sold in but a limited way, was found to be below guarantee throughout.

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*The Boston Co-operative Buyers Association, 77 Bedford St., Boston, Mass., has paid the license fee since the publication of Bulletin 58, but has not at the date of going to press filed its bond as required by law.

†Ninth Report, pp. 43-44.

Twelve out of twenty-two brands, deficient 0.20 per cent. or more in one, two or three ingredients, contained sufficient excess of other ingredients to afford the commercial equivalent or the money value of the guarantee. In seven cases, a part of the output of three companies, the shortage is not made good (commercially) by excess of other ingredients. One of the manufacturers claims that the samples do not properly represent his goods. The analyses made upon the same brands by the Stations of the various New England and Middle States during the two past years are in entire accord with the results herein reported. In one case the extraordinary shortage of one ingredient and the equally extraordinary excess of another makes a combination which "values" about the same as the guarantee but which is very different in composition from what might be expected. The analysis of this brand as sampled by this Station in 1896, and analyses made in years past by other New England Stations are in general accord with the results obtained by us this year. The manufacturers protest that the sample does not correctly represent the goods, but confirm its analysis by that of their own chemist. The Station vouches for the correctness of the sample. Both this brand and the "Dissolved Bone and Potash" already referred to have had but limited sale in the State.

The following table shows the number of brands sold by the different companies licensed in the State, the number of guarantees (nitrogen, available phosphoric acid, potash) made by each and the number of failures to make the same good (within 0.20 per cent.) as judged by the analyses of the samples taken by the Station.

| Name of Company. | Number of Brands. | Number of Guarantees. | Number of Guarantees not made good. |
|---|---|---|---|
| American Fertilizer Co | 4 | 12 | 1 |
| Boston Co-op. Buyers Assoc | 5 | 15 | 5 |
| Bowker Fertilizer Co | 19 | 56 | 0 |
| Bradley Fertilizer Co | 14 | 42 | 2 |
| Clark's Cove Fertilizer Co | 3 | 9 | 0 |
| Cleveland Dryer Co | 8 | 24 | 0 |
| E. Frank Coe Co | 14 | 41 | 5 |
| Crocker Fert. and Chem. Co | 6 | 18 | 1 |
| Cumberland Bone Phos. Co | 5 | 15 | 0 |
| Great Eastern Fertilizer Co | 4 | 11 | 0 |
| Lister's Agri. Chem. Works | 9 | 25 | 0 |
| Lowell Fertilizer Co | 5 | 15 | 4 |
| Pacific Guano Co | 3 | 9 | 0 |
| Parmenter & Polsey Co | 2 | 6 | 0 |
| Quinnipiac Co | 8 | 24 | 2 |
| Read Fertilizer Co | 8 | 23 | 1 |
| Russia Cement Co | 4 | 12 | 0 |
| Standard Fertilizer Co | 4 | 12 | 0 |
| Henry F. Tucker Co | 3 | 9 | 1 |
| Williams & Clark Fert. Co | 6 | 18 | 1 |
| Total | 134 | 396 | 23 |

*Sulphate of Potash.*—It is claimed, directly or inferentially, of 102 brands analyzed that sulphate of potash was used in the goods. Guarantees usually read "equal to" or "equivalent to" a given per cent. of sulphate of potash. This claim was shown in Bulletins 47 and 52 to have been, with a few notable exceptions, without foundation in fact. Seventeen of the 102 brands for which sulphate is claimed this year contained more or less of this material; 85 brands either contained none whatever, (muriate of potash, a cheaper and, for some purposes, a less desirable form of potash, being used), or carried an amount of chlorin sufficient to account for all the potash as muriate, and sufficient to neutralize the good effects, if any, to be expected of the sulphate. In other words, this particular guarantee was not made good in five-sixths of the cases. Seven companies licensed to sell in Vermont do not make this claim for their goods, or else, when claiming sulphate, use it. In three cases sulphate was used without any claim being made regarding it. Brands actually containing most if not all the potash as sulphate, are marked * in the tables of analyses.

*Availability of Organic Nitrogen.*—The Hayes acid-permanganate* and the pepsin digestion† methods for the determination of the availability of the organic nitrogen were used on all brands. The latter method as a rule gave higher results, but there was usually parallelism, goods showing low nitrogen availability by one being found similarly wanting by the other method. The following table shows brands grouped according to nitrogen availability as determined by the two methods.

| Availability. | Acid-permanganate. | Pepsin digestion. |
|---|---|---|
| Above 90 per cent | 0 | 1 |
| 80 to 89 per cent | 0 | 18 |
| 70 to 79 per cent | 14 | 67 |
| 60 to 69 per cent | 74 | 12 |
| 50 to 59 per cent | 31 | 23 |
| 40 to 49 per cent | 5 | 3 |

The samples showing less than sixty per cent. availability by either method were tested with iron phosphate dissolved in glacial phosphoric acid as suggested by Dabney‡ and by Lindsey‖.

The results were, however, negative in every case, no certain indications of the use of leather being found. No perfect method of detection of this material has been thus far discovered. It is safe to say, however, that a nitrogen availability below 50 is cause for suspicion. Fortunately but three brands seem to be beyond the dead line, which would indicate the probability that the trade in general uses the better grade of materials yielding organic nitrogen.

A further investigation and discussion of the matter of the availability of organic nitrogen is reserved for the annual report.

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* U. S. Dept. Agr., Chem. Div. Bul. 47, p. 112.
† Conn. Agl. Expt. Station, Rpt. 1893, p. 218.
‡ N. C. Agl. Expt. Station, Bul. 3.
‖ Mass. Agl. Expt. Station, 12th Rpt., pp. 300-301.

*Multiplicity of Brands.*—The rapid increase in the number of brands on sale in the State has been noted elsewhere. There can be no question that all farm requirements would be just as well met by thirty as by one hundred and thirty brands. This is particularly true when, as is often the case, several "brands" are shovelled from the self-same bin in the factory. When one finds two or more "brands" of the same make with identical guarantees, their common origin is obvious, notwithstanding one is labelled "corn phosphate" and the other "potato manure."

The names of the various goods seldom offer any clue to their character and are frequently positively misleading. The use of the word "bone" does not necessarily or even usually imply that the goods contain any bone. Neither does the fact that the words "potato" or "corn" appear upon the bags certify to the character of the goods because of wide divergencies in formulas. The more the brands the greater the expense of manufacture, of sale and of inspection, charges which the consumer ultimately pays. Competition more than popular demand has given rise to this condition which is confusing rather than helpful to the farmer.

*Selling Prices and Station Valuations.*—It has been the custom of this Station, in common with most Stations exercising fertilizer control, to indicate, in addition to the analyses of the various brands, the retail cash-cost at the seaboard of amounts of the three ingredients equal to those found, in unmixed standard raw materials of good quality; in other words, the so-called "Station valuation."

The "Station valuation" may be calculated by *multiplying the given per cent. of each constituent (nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.* In calculating valuations from guarantees it should be noted that the lower figure is all the seller is bound to deliver. For instance, 2 to 4 per cent. potash guarantees 2 per cent. only.

In calculating valuations from guarantees care should be taken to interpret the same properly. Many guarantees contain a vast array of figures and seem calculated to confuse rather than to instruct. The buyer will do well to note only the *lower figures* for nitrogen (*not* ammonia or nitrogen equivalent to ammonia), available phosphoric acid and potash (*not* sulphate of potash, or potash sulphate, or potash equivalent to or equal to sulphate) and to ignore all the remainder of the guarantee statement. In cases where ammonia or sulphate of potash only are given, their nitrogen and potash equivalents may be obtained by multiplying the respective guarantees by 0.823 and by 0.54.

It often occurs that buyers consider valuation rather than analysis. This is wrong; a brand may value high yet be ill adapted to a certain soil or crop. In so far as the valuation system tends to distract the buyer's attention from the composition of the goods and its fitness for his special needs, it fails in its mission. Yet valuations are of much use, showing whether a given brand is worth its cost from a commercial standpoint and furnishing a common basis on which to compare the commercial values of different fertilizers.

A comparison of the selling prices and valuations of 129 brands sold this year in Vermont shows the averages to be ; selling price, $29.19, "valuation," $19.47, difference $9.72, an advance of 50 per cent. over valuation (9.72÷19.47=0.50.)

Selling prices necessarily exceed valuations, since the latter show only the seaboard values of unmixed ingredients and do not include necessary and legitimate charges accompanying the manufacture and sale of mixed goods, such as mixing, bagging, storage, freight, commissions to agents and dealers, selling on long credit. bad debts, interest on investment, depreciation of plant, profits, etc. Stating the case another way, on the average one dollar out of every three spent for commercial fertilizers this year in Vermont went to pay for mixing, bagging, freighting and selling the goods. Within these averages, however, lie concealed many cases of comparitively high prices for low grade goods.

The question of the *relation of the selling price to the value of the plant food contained* is of quite as much importance as that of a manufacturer's exact compliance with a guarantee statement of his own choice. It is a matter, however, which no law can touch. No law can prevent a shoe maker from charging five dollars for a two dollar pair of shoes, nor can he who ignorantly buys at that price invoke the legal arm. Similarly no statute can regulate the price at which commercial fertilizers shall sell or the relation of that price to the value of the goods.

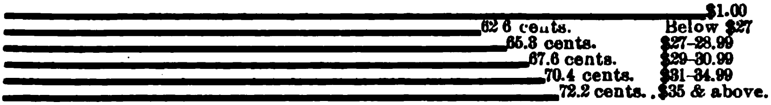
It is to be hoped that the "unit system" of purchase which is in vogue among the manufacturers in the purchase of raw materials may come into use in the sale of mixed goods. A "unit" is 20 pounds of actual plant food per ton of fertilizer which is equivalent to one per cent. The guarantee upon the bags stating percentages likewise states units, since both are the same. Fertilizers bought on the "unit system" are paid for in accordance with their actual composition just as milk in now bought at creameries and cheese factories upon analysis.

This "actual composition" might be obtained by the use of the regular Station analysis or by the analysis of the particular lot thus bought. Many of the manufacturers are willing to sell on this basis, which is obviously entirely fair to both parties. Unit prices for the current year of the average goods sold in Vermont have been nitrogen, $4.20, available phosphoric acid $1.74, potash, $1.35. Goods containing 2.5 per cent. nitrogen, 9 per cent. available phosphoric acid and 3 per cent. potash would sell for $30.21. (2.5×4.20+9×1.74+3×1.35=30.21.) Under this system the purchaser would buy where he can get *plant food* the cheapest, not, as now, too frequently happens where he can get the most *weight*, be it plant food or not, for his money. The general use of such a system of purchase would render the relation between selling prices and actual values entirely clear.

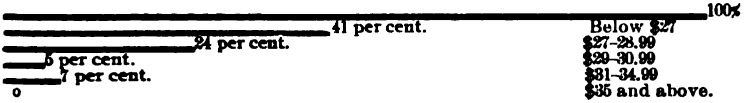
Turning now from general averages to those of different grades, the following table*, comparing selling prices and valuations of average goods of different selling prices is very suggestive:

| Selling Price. | Number of brands in group. | Cents worth of plant food at retail seaboard prices bought for a dollar at consumer's depot. | | | Number of brands in group which furnish for a dollar | |
|---|---|---|---|---|---|---|
| | | Highest. | Lowest. | Average. | Less than 60 cents worth plant food. | More than 70 cents worth plant food. |
| Below $27 | 34 | 81 | 50 | 62.6 | 14 | 4 |
| $27-28.99 | 42 | 75 | 52 | 65.3 | 10 | 8 |
| $29-30.99 | 20 | 75 | 58 | 67.6 | 1 | 4 |
| $31-34.99 | 15 | 85 | 58 | 70.4 | 1 | 6 |
| $35 and above | 18 | 86 | 60 | 72.2 | 0 | 13 |

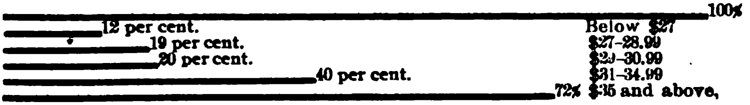
These points can be shown graphically. The relative lengths of the following lines indicate the average cents' worth of plant food at retail seaboard prices bought for a dollar at consumer's depot in brands selling between prices given:



The following lines shows the per cent. of the total number of brands in each group selling between the prices given which contain *less than 60 cents worth of plant food* at retail seaboard prices for the dollar invested at the consumer's depot.



The final set of lines shows the per cent. of the total number of brands in each group selling between the prices given which contain *more than 70 cents worth of plant food* at retail seaboard prices for the dollar invested at the consumer's depot.



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*Five brands sampled after the table was made are not included therein although they appear in the tables of analyses.

Translating figures and lines into words, it should be noted that:

(1) *A dollar spent for average low priced brands (below $29) bought 64 cents worth of plant food at retail seaboard prices; a dollar invested in average medium grade goods ($29 to $35), 69 cents worth; and a dollar paid out for average high class goods ($35 and upwards), 72 cents worth.** A dollar bought 86 cents worth of plant food in one brand sold in the State this year, while it purchased but 50 cents worth in another brand. *One-fifth* of the entire number of brands furnish less than 60 cents worth of plant food to the dollar.

(2) *Thirty-two per cent. of the total number of low priced goods contain plant food worth less than 60 cents for each dollar of cost*, while but *six per cent.* of the total number of medium grade and *none* of the high grade brands contain as little *relative* value as this.

(3) *Seventy-two per cent. of the total number of high class goods contain plant food worth more than 70 cents for each dollar of cost*, while but *twenty-nine* per cent. of the total number of medium grade and *sixteen* per cent. of the total number of low priced brands contained as much *relative* value as this.

Low grade brands cost relatively high prices because the expense of manufacture and sale are equally great as and proportionately greater than those on high class goods. The companies as a rule prefer to sell the better goods, but there is a wide-spread popular demand for low priced goods, a desire "to get a lot for their money." General and local fertilizer agents report difficulty in selling the higher grades, which must usually prove more satisfactory because of the greater economy of purchase and the greater likelihood that first-class materials are used in manufacture.

The goods which proved to contain the largest value of plant food for the dollar asked, as judged by the 1896 analyses of this Station, could not be sold at $33.00 a ton in a market in which lower grades sold well. Its selling price was dropped to close it out, a portion of the lot was bought by one of the Station officers for use upon his private farm, and field results fully sustained the laboratory analysis.

The average selling price of mixed goods is $1.71 lower than last year. Plant food is cheaper than ever before, yet notwithstanding it is doubtful whether at present prices for farm produce many farmers can afford to pay much more than 40 cents out of every dollar invested in fertilizers to manufacturer, laborer, railroad and dealer. Yet on the other hand, by careful choice, or, under some circumstances, by the practice of home mixing, the use of commercial fertilizers even at present crop prices may prove profitable, particularly if supplemented by proper feeding of farm stock and care for the manure.

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*An illustration of the method of making this comparison may prove helpful. A brand of fertilizer containing 2 per cent. of nitrogen, 9 per cent. of total phosphoric acid, 8 per cent. of available phosphoric acid and 6 per cent. of potash sells at consumer's depot for $33. In the absence of analysis, guarantee may be taken as a basis of calculating "valuation," which is found to be $20.20. 20.20÷33=0.61. A dollar buys sixty-one cents worth of plant food and thirty-nine cents is paid for manufacture, transportation and selling expenses.

*Agricultural Value of Fertilizers.*—It should of course be borne in mind that the comparisons shown are made from the *commercial* standpoint only and are designed simply to determine whether prices asked are reasonable. As has been already pointed out, one should not fail to consider the composition of the goods as of much more importance than the valuation. One should not buy nitrogen if it is not needed because in a particular fertilizer it is cheap. A brand rich in nitrogen, the most costly of the three deficient essential elements of plant food, may value high, and yet the crop returns, on a soil loaded with nitrogen, or with a crop needing but little artificial supply of this ingredient, or when one has plenty of good barnyard manure and uses his commercial fertilizer as a supplement thereto, may prove inferior to those obtained with a brand rich in other constituents less valuable commercially, but for which soil or crop hungers.

Previous experience with similar goods, previous manuring and cropping of the land, the demands of the crop to be grown upon the soil, the character of the soil, as well as the fitness of the brand under consideration to soil, to crop and as supplementing home manurial supplies, should all be taken into account, and then, and not till then, the relation between selling price and Station valuation should receive due weight.

## III. LICENSED FERTILIZERS SAMPLED BY STATION.*

### American Fertilizer Co., Boston, Mass.

5544. **Alkali Nitrate Phosphate for Hoed Crops**; from stocks of Charles Felch, Passumpsic; J. M. Bond, Hartford; E. S. Johnson, Townshend.

5545. **General American for all Crops**; from stocks of Charles Felch, Passumpsic; J. M. Boyd, Hartford; F. A. Leland, Chester Depot.

5546. **Potato**; from stocks of J. M. Boyd, Hartford; F. A. Leland, Chester Depot; E. S. Johnson, Townshend.

### Bowker Fertilizer Co., Boston, Mass.

5372. **Ammoniated Corn Phosphate**; from stock of A. L. Aseltine, Swanton.

5191. **Farm and Garden Phosphate**; from stock of A. E. Fuller, Woodstock.

5421. **Market Garden Fertilizer**; from stock of A. E. Fuller, Woodstock.

5371. **Potash Bone**; from stock of L. J. Sanderson, Highgate.

5423. **Potato and Vegetable Manure**; from stock of A. E. Fuller, Woodstock.

5420. **Square Brand Bone and Potash**; from stock of A. E. Fuller, Woodstock.

5533. **Staple Phosphate**; from stock of Edwards and Grout, Newfane.

5346. **Stockbridge Manure for Onions**; from stock of Stocker Bros., Danville.

5456. **Stockbridge Manure for Seeding Down**; from stock of C. G. and H. F. Leach, North Rupert.

5513. **Stockbridge Manure for Top Dressing**; from stocks of G. A. Wales, South Barre; A. E. Fuller, Woodstock.

5549. **Superphosphate with Potash**; from stock of A. J. Brown, Springfield.

5418. **Vermont Grange Chemicals, D. Brand**; from stock of A. E. Fuller, Woodstock.

### Bradley Fertilizer Co., Boston, Mass.

5129. **B. D. Sea Fowl Guano**; from stock of Maynard & Marsh, Sheldon.

5142. **Complete Manure for Corn and Grain**; from stock of E. A. Morse, Calais.

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*The names and locations of agents from whom samples were taken which made analytical samples reported in Bulletins 57 and 58 and reprinted in this bulletin may be found on reference thereto.

5143. **Complete Manure for Potatoes and Vegetables**; from stock of E. A. Morse, Calais.

5548. **English Lawn Fertilizer**; from stock of A. G. Pierce, Burlington.

5413. **Original Coe's Superphosphate of Lime**; from stock of Penniman and Payson, Windsor.

5231. **Seeding Down Manure**; from stock of M. G. Armstrong, Norwich.

### Clark's Cove Fertilizer Co., Boston, Mass.

5525. **Potato and Tobacco Fertilizer**; from stocks of Knight and Walker, West Brattleboro; J. H. Silsby, Lunenburgh.

### Cleveland Dryer Co., Boston, Mass.

5146 **High Grade Complete Manure**; from stock of M. A. Nelson, Montpelier.

5351. **Pioneer Fertilizer**; from stock of M. D. Bowker, Lunenburgh.

5526. **Seeding Down Fertilizer**; from stock of C. W. Merriam, Elmore.

5350. **Special for Wheat, Rye and Oats**; from stock of J. P. Telfer, Barton.

### E. Frank Coe Co., New York, N. Y.

5051. **Bay State Imperial Superphosphate**; from stock of H. L. Page, Essex Centre.

5322. **Celebrated Special Potato Fertilizer**; from stock of Jordan Bros., Jericho Centre.

5437. **Columbian Ammoniated Bone Superphosphate**; from stock of Farnsworth & Co., Middlebury.

5445. **Dissolved Bone and Potash**; from stock of Silas Giddings, Castleton.

5364. **Excelsior Potato Fertilizer**; from stock of L. H. Shonyo & Son. Lyndonville.

5518 **Gold Brand Excelsior Guano**; from stocks of Silas Giddings, Castleton; F. A. Crane, Danville.

5527. **Ground Bone and Potash**; from stock of L. F. Shonyo & Son, Lyndonville.

5323. **High Grade Ammoniated Bone Superphosphate**; from stock of Jordan Bros., Jericho Centre.

5444. **Red Brand Excelsior Guano**; from stock of Silas Giddings, Castleton.

5516. **Standard Grade Ammoniated Bone Superphosphate**; from stocks of H. L. Page, Essex Centre; Jordan Bros., Jericho Centre.

5517. **XXV Superphosphate**; from stocks of E. B. Whipple, Westford; Edwards & Gloyd, Richmond.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

5519. **Special Potato Manure**; from stocks of J. N. Warner, St. Albans; F. E. Powers, Pawlet.

### Cumberland Bone Phosphate Co., Boston, Mass.

5520. **Fertilizer**; from stocks of C. C. Buck, Woodstock; E. B. Moody, Waterbury Centre.

### Lister's Agricultural Chemical Works, Newark, N. J.

5426. **Animal Bone and Potash, No. 2**; from stock of H. H. Ormsby, Bradford.

5524. **Harvest Queen Phosphate**; from stocks of V. L. Perking, Warren; C. L. Hodges, Randolph.

5167. **Perfect Fertilizer**; from stock of C. L. Hodges, Randolph.

5542. **Potato Manure**; from stock of M. V. Leach, Essex Centre.

5539. **Potato Fertilizer, No. 2**; from stock of G. W. Bates, Springfield.

5194. **United States Superphosphate**; from stock of C. K. Thompson, Woodstock.

### Lowell Fertilizer Co., Boston, Mass.

5434. **Animal Brand**; from stock of A. M. Heath, Groton.

5138. **Dissolved Bone and Potash**; from stock of C. D. Loukes, Highgate.

5433. **Complete Manure for Vegetables**; from stock of A. M. Heath, Groton.

### Pacific Guano Co., Boston, Mass.

5523. **Nobsque Guano**; from stocks of E. Walbridge, North Bennington; J. Penney, Ludlow.

### Quinnipiac Co., Boston, Mass.

5455. **Market Garden Manure**; from stock of T. Dean, Pawlet.

5538. **Phosphate**; from stock of Mellin & Proctor, Brattleboro.

5332. **Pine Island Phosphate**; from stock of E. E. Harris, Morris ville.

5469. **Potato Manure**; from stock of A. A. Dunklee, South Vernon.

5452. **Seeding Down Fertilizer**; from stock of H. Ballard, Poultney.

### Read Fertilizer Co., New York, N. Y.

5547. **Corn and Wheat Mixture**; from stock of W. H. Burr, Pearl.

5356. **Prime Wheat and Rye Fertilizer**; from stock of W. S. Russell, East St. Johnsbury.

### Russia Cement Co., Gloucester, Mass.

5514. **Complete Manure for Potatoes, Roots and Vegetables**; from stocks of R. C. Martin, Bradford; M. N. Carter, Wells River.

5515. **High Grade Superphosphate**; from stocks of C. F. Eddy, Waitsfield; R. C. Martin, Bradford.

### Standard Fertilizer Co., Boston, Mass.

5543. **Guano**; from stock of J. H. Bushnell, Williston.

5522. **Potato and Tobacco Fertilizer**; from stocks of C. W. Atherton, Waterbury; H. L. Gilman, Groton.

5335. **Superphosphate**; from stock of L. H. Lamphier, Morrisville.

### Williams & Clark Fertilizer Co., New York, N. Y.

5521. **Americus Potato Phosphate**; from stocks of Edward Whitcomb, Essex Centre; M. V. Willard, Jericho Centre.

5086. **High Grade Special**; from stock of J. H. McDowell, Greensboro.

### Boston Co-operative Buyers Association, Boston, Mass.

5560. **Massachusetts State Grange Complete for Corn and Grain**; from stock of Willard Bros., East Montpelier.

5561. **Massachusetts State Grange Complete for Potatoes and Vegetables**; from stock of Willard Bros., East Montpelier.

5559. **Massachusetts State Grange General Fertilizer**; from stock of Willard Bros., East Montpelier.

5558. **Massachusetts State Grange Superphosphate**; from stock of Willard Bros., East Montpelier.

5562. **Massachusetts State Grange Top Dressing**; from stock of Willard Bros., East Montpelier.

### Bowker Fertilizer Co., Boston, Mass.

5557. **Vermont Phosphate**; from stock of Perley and Leavens, Cambridge.

## IV. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. From Nitrates. | Nitrogen. From Ammonia Salts. | Nitrogen. From Organic Matter. | Nitrogen. Total Found. | Nitrogen. Total Guaranteed. | Nitrogen. Valuation of Nitrogen in One Ton. | Phosphoric Acid. Soluble. | Phosphoric Acid. Reverted. | Phosphoric Acid. Insoluble. | Phosphoric Acid. Total. Found. | Phosphoric Acid. Total. Guaranteed. | Phosphoric Acid. Available. Found. | Phosphoric Acid. Available. Guaranteed. | Phosphoric Acid. Valuation of Phosphoric Acid in One Ton. | Potash. Found. | Potash. Guaranteed. | Potash. Valuation of Potash in One Ton. | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ‡*†5478 | American Fert. Co. Alk. Nit. Phos. | 2.90 | .... | ... | **2.90** | *3.29* | $8.12 | 0.07 | 12.25 | 7.14 | **19.46** | .... | **12.32** | *11.* | $15.19 | **4.01** | *4.* | $3.86 | 5478 |
| 5544 | American Alk. Nit. Phos. Hoed Cps | 3.29 | .... | - - | **3.29** | *3.29* | 9.21 | 0.03 | 12.07 | 6.40 | **18.50** | *17.* | **12.10** | *11.* | 14.66 | **4.31** | *4.* | 3.86 | 5544 |
| 5545 | American General for All Crops.... | .... | .... | 1.71 | **1.71** | *1.64* | 4.79 | .... | 7.75 | 2.45 | **10.20** | *9.* | **7.75** | *6.* | 8.73 | **2.95** | *2.* | 2.66 | 5545 |
| 5546 | American Potato................. | .... | .... | 2.60 | **2.60** | *2.47* | 7.28 | 0.02 | 8.13 | 2.15 | **10.30** | .... | **8.15** | *6.* | 9.01 | **8.91** | *9.* | 8.02 | 5546 |
| 5872 | Bowker's Ammoniated Corn Phos . | 0.74 | .... | 1.04 | **1.78** | *1.5* | 4.98 | 5.45 | 4.00 | 2.77 | **12.22** | *11.* | **9·45** | *9.* | 11.10 | **2.25** | *2.* | 2.02 | 5372 |
| 5191 | Bowker's Farm and Garden Phos .. | 0.78 | .... | 1.05 | **1.78** | *1.6* | 4.98 | 4.85 | 4.42 | 3.36 | **12.13** | *10.* | **8·77** | *8.* | 10.55 | **2.29** | *2.* | 2.06 | 5191 |
| †5309 | Bowker's Hill and Drill Phosphate. | 0.81 | .... | 1.61 | **2.42** | *2.5* | 6.78 | 9.00 | 3.08 | 1.70 | **13.73** | *12.* | **12.03** | *9.* | 18.61 | **2.39** | *2.* | 2.15 | 5309 |
| 5421 | Bowker's Market Garden Fertilizer | 0.76 | ... | 1.65 | **2.41** | *2.25* | 6.75 | 2.40 | 3.55 | 5.47 | **11.42** | *8.* | **5.95** | *6.* | 8.38 | **11·10** | *10.* | 9.99 | 5421 |
| 5371 | Bowker's Potash Bone............. | -- - | .... | 0.98 | **0.98** | *0.75* | 2.74 | 2.42 | 2.47 | 4.30 | **9.19** | *7.* | **4.89** | *5.* | 6.85 | **2.31** | *2.* | 2.08 | 5371 |
| †5495 | Bowker's Potash Phosphate........ | 0.27 | .... | 0.67 | **0.94** | *0.75* | 2.63 | 1.41 | 6.77 | 4.68 | **12.81** | *10.* | **8.18** | *8.* | 10.17 | **3.50** | *3.* | 3.15 | 5495 |
| 5428 | Bowker's Potato and Vegetable Man. | 0.65 | .... | 1.76 | **2.41** | *2.25* | 6.75 | 6.65 | 2.26 | 3.00 | **10.91** | *10.* | **8.91** | *8.* | 10.88 | **4.52** | *4.* | 4.07 | 5428 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. †Reprinted from Bulletin 58. ‡These goods were shipped into the State last year; the company not being then licensed they were ordered held and were offered for sale this year.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5506 | Bowker's Potato and Veg. Phos ... | 0.77 | .... | 1.00 | **1.77** | *1.5* | $4.96 | 3.82 | 4.60 | 3.76 | **12.18** | *10.* | **8.42** | *8.* | $10.31 | **2.09** | *2.* | $1.88 | 5506 |
| 5420 | Bowker's Square Brand Bone & Pot. | .... | .... | 1.68 | **1.68** | *1.5* | 4.70 | 1.79 | 5.62 | 5.40 | **12.81** | .... | **7.41** | *6.* | 9.75 | **2 23** | *2.* | 2.01 | 5420 |
| 5583 | Bowker's Staple Phosphate.... .... | .... | .... | 0.99 | **0.99** | *0.75* | 2.77 | 3.93 | 4.82 | 2.27 | **10.52** | *10.* | **8.25** | *8.* | 9.55 | **3.11** | *3.* | 2.80 | 5583 |
| †5307 | Bowker's Stockbridge Corn Manure | 1.24 | .... | 2.08 | **3.32** | *3.25* | 9.30 | 6.69 | 2.75 | 1.80 | **11.24** | *10.* | **9.44** | *8.* | 10.83 | **7.39** | *6.* | 6.65 | 5307 |
| 5346 | Bowker's Stockbridge Onion Manure | 3.08 | .... | 2.20 | **5.28** | *4.5* | 14.78 | 4.79 | 2.15 | 1.67 | **8.61** | *8.* | **6.94** | *6.* | 8.09 | **6.87** | *5.* | 6 18 | 5346 |
| †5308 | Bowker's StockbridgePotato Manure | 1.50 | .... | 1.90 | **3.40** | *3.25* | 9.52 | 5.94 | 2.39 | 0.98 | **9.31** | *7.* | **8.33** | *5.* | 9.32 | **10 44** | *10.* | 9.40 | 5308 |
| 5456 | Bowker's Stockb'ge Se'd'ng D'n M're | 0.63 | .... | 1.54 | **2.17** | *2.25* | 6.08 | 2.46 | 4.50 | 4.86 | **11.82** | *10.* | **6.96** | *6.* | 9.15 | **10.12** | *10.* | 9.11 | 5456 |
| 5513 | Bowker's Stockb'ge Top Dr'sng M're | 2.67 | .... | 2.22 | **4.89** | *5.* | 13.69 | 3.25 | 3.41 | 3.51 | **10.17** | *6.* | **6.66** | *4.* | 8.39 | **6.62** | *6.* | 5.96 | 5513 |
| 5549 | Bowker's Superphos. with Potash.. | .... | .... | .. . | .... | . .. | .... | 3.15 | 7.06 | 4.02 | **14.23** | *12.* | **10.21** | *10.* | 12.18 | **1.22** | *1.* | 1.10 | 5549 |
| †5505 | Bowker's Sure Crop Phosphate..... | 0.26 | .... | 0.80 | **1.06** | *0.75* | 2.97 | 4.99 | 4.55 | 2.68 | **12.22** | *10.* | **9.54** | *8.* | 11.11 | **1.46** | *1.* | 1.31 | 3505 |
| 5418 | Bowker's Vt.Grange Chem. D. Brand | 0.51 | .... | 1.82 | **2.33** | *2.06* | 6.52 | 6.90 | 2.64 | 1.63 | **11.17** | *9.* | **9.54** | *8.* | 10.88 | **4.08** | *3.* | 3.67 | 5418 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. †Reprinted from Bulletin 58.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5494 | Bowker's Vermont Phosphate...... | 0.62 | .... | 1.43 | 2.05 | *1.75* | $5.74 | 4.20 | 4.01 | 3.32 | 11.53 | *10.* | 8.21 | *8.* | $ 9.96 | 3.32 | *3.* | $2.99 | 5494 |
| 5129 | Bradley's B. D. Sea Fowl Guano. .. | 0.58 | .... | 1.54 | 2.12 | *2.06* | 5.94 | 6.21 | 3.64 | 1.18 | 11.03 | *10.* | 9.85 | *8.* | 10.94 | 1.88 | *1.5* | 1.69 | 5129 |
| 5142 | Bradley's Complete Corn and Grain | .... | 0.86 | 2.60 | 3.46 | *3.3* | 9.60 | 4.62 | 4.55 | 2.46 | 11.63 | *13.* | 9.17 | *12.* | 10.62 | 5.54 | *3.* | 4.99 | 5142 |
| 5143 | Bradley's Complete Potato & Veget | .... | 0.94 | 2.77 | 3.71 | *3.73* | 10.29 | 5.10 | 3.36 | 1.78 | 10.24 | *9.* | 8.46 | *8.* | 9.68 | 6.15 | *6.* | 5.53 | 5143 |
| †*5481 | Bradley's Complete Top Dressing... | 5.41 | .... | .... | 5.41 | *4.95* | 15.15 | 1.49 | 3.75 | 1.20 | 6.44 | *6.* | 5.24 | *5.* | 5.87 | 3.05 | *2.5* | 2.88 | 5481 |
| †5281 | Bradley's Corn Phosphate..... .... | 0.20 | .... | 2.12 | 2.32 | *2.06* | 6.50 | 6.25 | 3.34 | 1.83 | 11.42 | *10.* | 9.59 | *9.* | 10.95 | 1.82 | *1.5* | 1.64 | 5281 |
| †5297 | Bradley's Eclipse Phosphate....... | .... | .... | 1.89 | 1.89 | *1.* | 5.29 | 5.32 | 3.79 | 2.24 | 11.35 | *12.* | 9.11 | *10.* | 10.54 | 1.60 | *1.5* | 1.44 | 5297 |
| *5548 | Bradley's English Lawn Fertilizer.. | 4.95 | .... | .... | 4.95 | *4.95* | 18.86 | 1.20 | 4.97 | 1.20 | 7.37 | *6.* | 6 17 | *5.* | 6.77 | 2.78 | *2.5* | 2.68 | 5548 |
| 5413 | Bradley's Original Coe's Superphos. | .... | .... | 2.17 | 2.17 | *2.05* | 6.08 | 6.10 | 3.20 | 1.53 | 10 83 | *10.* | 9.30 | *8.* | 10.52 | 2.51 | *1.* | 2.26 | 5413 |
| †5811 | Bradley's Patent Superphosphate .. | .... | .... | 2.37 | 2.37 | *2.05* | 6.64 | 6.24 | 4.11 | 2.04 | 12.39 | *11.* | 10.35 | *9.* | 11.79 | 1.82 | *2.* | 1.64 | 5811 |
| †5298 | Bradley's Potato Fertilizer......... | .... | .... | 2.47 | 2.47 | *2.06* | 6.92 | 6.68 | 2.40 | 2.35 | 11.38 | *11.* | 9.03 | *9.* | 10.68 | 3.62 | *3.25* | 3.26 | 5298 |

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# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5482 | Bradley's Potato Manure............ | 0.27 | .... | 2.20 | **2.47** | *2.5* | $6.92 | 4.29 | 2.15 | 2.31 | **8.75** | *8.* | **6.44** | *6.* | $ 7.79 | **5.38** | *5.* | $4.84 | 5482 |
| 5281 | Bradley's Seeding Down Manure... | .... | .... | 2.76 | **2.76** | *2.5* | 7.78 | 6.33 | 4.12 | 2.40 | **12.85** | *12.* | **10.45** | *7.* | 12.04 | **2.12** | *2.* | 1.91 | 5281 |
| †5299 | Bradley's Vermonter for all Crops.. | .... | .... | 2.24 | **2.24** | *2.06* | 6.27 | 6.30 | 2.43 | 2.29 | **11.02** | *10.* | **8.73** | *8.* | 10.28 | **4.56** | *3.5* | 4.10 | 5299 |
| †5300 | Bradley's XL Superphosphate...... | .... | 0.12 | 2.43 | **2.55** | *2.5* | 7.13 | 6.39 | 3.72 | 2.40 | **12.51** | *11.* | **10.11** | *9.* | 11.71 | **1.86** | *2.* | 1 67 | 5300 |
| †5497 | Clark's Cove Bay State Fert. G. G.. | .... | .... | 2.20 | **2.20** | *1.85* | 6.16 | 4.90 | 4.36 | 2.86 | **11.62** | *10.* | **9.26** | *8.5* | 10.69 | **2.06** | *2.* | 1.85 | 5497 |
| †5225 | Clark's Cove King Philip Alk. Guano | .... | .... | 1.30 | **1.30** | *1.03* | 3.64 | 5.40 | 3.18 | 2.16 | **10.74** | *9.* | **8.58** | *8.* | 9.98 | **2.00** | *2.* | 1.80 | 5225 |
| 5525 | Clark's Cove Potato and Tobac. Fert. | .... | .... | 2.32 | **2.32** | *2.06* | 6.50 | 6.56 | 2.40 | 2.40 | **11.36** | *9.* | **8.96** | *8.* | 10.58 | **3.62** | *3.* | 3.26 | 5525 |
| †5291 | Cleveland Corn and Grain Phosphate | 0.15 | .... | 2.15 | **2.30** | *2.06* | 6.44 | 4.95 | 4.88 | 2.52 | **11.85** | *10.5* | **9.33** | *9.5* | 10.83 | **1.69** | *1.5* | 1.52 | 5291 |
| †5301 | Cleveland Fertilizer for all Crops... | .... | .... | 1.25 | **1.25** | *1.03* | 3.50 | 6.63 | 2.11 | 1.66 | **10.40** | *9.* | **8.74** | *8.* | 10.07 | **2.39** | *2.* | 2.15 | 5301 |
| 5146 | Cleveland High Grade Complete M'r | .... | 0.95 | 2.55 | **3.50** | *3.3* | 9.71 | 4.97 | 3.87 | 1.34 | **10.18** | *9.* | **8.84** | *8.* | 9.87 | **6.81** | *7.* | 6.13 | 5146 |
| 5351 | Cleveland Pioneer Fertilizer.... ... | .... | .... | 1.06 | **1.06** | *0.82* | 2.97 | 5.49 | 2.46 | 1.10 | **9.05** | *9.* | **7.95** | *7.* | 8.94 | **1.26** | *1.* | 1.13 | 5351 |

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## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5285 | Cleveland Potato Phosphate... ..... | .... | .... | 2.17 | **2.17** | *2.06* | $6.08 | 6.41 | 3.23 | 1.92 | **11.56** | *10.* | **9.64** | *8.* | $11.05 | **3 22** | *3.* | $2.90 | 5285 |
| 5526 | Cleveland Seeding Down Fertilizer. | .... | .... | 1.93 | **1.93** | *1.65* | 5.42 | 4.09 | 2.57 | 3.71 | **10.37** | *10.* | **6.66** | *5.* | 8.55 | **2.35** | *2.* | 2.11 | 5526 |
| 5350 | Cleveland Specl. for Wheat, Rye, Oats | .... | .... | 1.37 | **1.37** | *0.82* | 3.84 | 5.46 | 2.97 | 1.65 | **10.08** | *9.* | **8.43** | *7.* | 9.64 | **1.21** | *1.* | 1.09 | 5350 |
| †5492 | Cleveland Superphosphate .... .... | .... | .... | 2.15 | **2.15** | *2.05* | 6.02 | 5.55 | 3.60 | 2.22 | **11.37** | *11.* | **9.15** | *9.* | 10.59 | **2.00** | *2.* | 1.80 | 5492 |
| *5051 | Coe's Bay State Imperial Superphos | .... | .... | 1.38 | **1.38** | *1.2* | 3.86 | 7.40 | 3.39 | 2.45 | **13.24** | *11.* | **10.79** | *9.* | 12.51 | **1.98** | *1.85* | 1.91 | 5051 |
| †*5504 | Coe's Celebrated Grass and Grain... | .... | .... | 1.08 | **1.08** | *0.8* | 3.02 | 7.10 | 3.74 | 3.04 | **13.88** | *10.* | **10.84** | *9.* | 12.77 | **1.59** | *1.35* | 1.47 | 5504 |
| *5822 | Coe's Celebrated Potato Fertilizer | .... | 0.89 | 1.32 | **1.71** | *1.65* | 4.75 | 7.00 | 3.18 | 2.25 | **12.38** | *11.* | **10.13** | *9.* | 11.73 | **3.44** | *3.5* | 3.41 | 5822 |
| *5437 | Coe's Columbian Ammo. Bone...... | .... | 0.16 | 1.40 | **1.56** | *1.2* | 4.35 | 7.10 | 3.29 | 2.57 | **12.96** | *11.* | **10.39** | *9.* | 12.18 | **1.75** | *1.85* | 1.64 | 5437 |
| *†5804 | Coe's Columbian Corn Fertilizer.... | .... | .... | 1.44 | **1.44** | *1.2* | 4.08 | 7.48 | 2.76 | 2.54 | **12.78** | *11.* | **10.24** | *9.* | 12.00 | **1.82** | *1.85* | 1.81 | 5804 |
| *†5287 | Coe's Columbian Potato Fertilizer.. | .... | 0.18 | 1.39 | **1.52** | *1.2* | 4.24 | 7.27 | 2.82 | 2.55 | **12.64** | *11.* | **10.09** | *9.* | 11.84 | **1.96** | *1.85* | 1.94 | 5287 |
| *5445 | Coe's Dissolved Bone and Potash... | .... | ... | .. -- | .... | -- - | .... | 6.81 | 4.52 | 2.65 | **13.98** | *14.* | **11.33** | *12.* | 13.07 | **2.06** | *2.5* | 1.97 | 5445 |

* Potash in brands thus marked is largely if not entirely, in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| *5364 | Coe's Excelsior Potato Fertilizer | .... | 0.57 | 2.20 | **2.77** | *2.5* | $7.70 | 6.34 | 1.71 | 2.22 | **10.27** | *9.* | **8.05** | *8.* | $ 9.57 | **7.25** | *8.* | $7.07 | 5364 |
| *5518 | Coe's Gold Brand Excelsior Guano | .... | 0.88 | 1.78 | **2.61** | *2.5* | 7.23 | 6.04 | 2.23 | 1.85 | **10.12** | *9.* | **8.27** | *8.* | 9.61 | **5.69** | *6.* | 5.59 | 5518 |
| 5527 | Coe's Ground Bone and Potash | .... | .... | 2.05 | **2 05** | *2.* | 5.74 | 0.06 | 9.99 | 7.02 | **17.07** | *12.8* | **10.05** | .. | 12.86 | **2.64** | *2.5* | 2.38 | 5527 |
| *5323 | Coe's High Grade Ammo. Bone | .... | 0.14 | 1.82 | **1.96** | *2.* | 5.47 | 6.71 | 3.12 | 2.31 | **12.14** | *11.* | **9.83** | *9.* | 11.43 | **1.73** | *1.85* | 1.67 | 5323 |
| *5444 | Coe's Red Brand Excelsior Guano | .... | 0.81 | 2.70 | **3.51** | *3.5* | 9.75 | 6.46 | 2.08 | 1.62 | **10.11** | *10.* | **8.49** | *9.* | 9.78 | **5.91** | *6.* | 5.75 | 5444 |
| *5516 | Coe's Standard Ammo. Bone | .... | 0.18 | 1.76 | **1.89** | *1.75* | 5.28 | 7.18 | 3.06 | 2.46 | **12.70** | *9.* | **10.24** | *8.* | 11.94 | **1.52** | *1.35* | 1.47 | 5516 |
| *5517 | Coe's XXV Ammo. Bone Superphos | .... | .... | 1.07 | **1.07** | *1.* | 3.00 | 6.57 | 4.64 | 2.58 | **13.79** | *9.* | **11.21** | *8.* | 12.90 | **1.08** | *1.* | 1.04 | 5517 |
| †5303 | Crocker's Ammo. Bone Superphos | .... | .... | 2.70 | **2.70** | *2.9* | 7.56 | 8.63 | 2.84 | 0.55 | **11.52** | *11.* | **10.97** | *10.* | 12.05 | **1.39** | *1.08* | 1.25 | 5303 |
| †5302 | Crocker's Ammo. Corn Phosphate | .... | .... | 2.14 | **2.14** | *2.* | 5.99 | 7.49 | 2.97 | 1.68 | **12.14** | *11.* | **10.46** | *10.* | 11.88 | **1.79** | *1.6* | 1.61 | 5302 |
| †5484 | Crocker's New Rival Ammo. Bone | .... | ... | 1.85 | **1.35** | *1.23* | 3.78 | 7.52 | 2.75 | 1.14 | **11.41** | *11.* | **10.27** | *10.* | 11.48 | **1.92** | *1.6* | 1.73 | 5484 |
| †5485 | Crocker's Potato, Hop and Tobacco | .... | .... | 2.22 | **2.22** | *2.* | 6.22 | 8.34 | 2.67 | 0.65 | **11.66** | *11.* | **11.01** | *10.* | 12.10 | **3.56** | *3.25* | 3.20 | 5485 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| 5519 | Crocker's Special Potato Manure... | .... | .... | 4.04 | 4.04 | 3.7 | $11.31 | 5.66 | 2.58 | 1.20 | 9.44 | 9. | 8.24 | 8. | $9.29 | 5.17 | 5.4 | $4.65 | 5519 |
| †5489 | Crocker's Superior Rye and Oats... | .... | .... | 1.06 | 1.06 | 0.82 | 2.97 | 6.61 | 2.48 | 1.43 | 10.52 | 9. | 9.09 | 8. | 10.32 | 1.94 | 2. | 1.75 | 5489 |
| 5520 | Cumberland Fertilizer.............. | .... | .... | 1.21 | 1.21 | 1.03 | 3.39 | 4.68 | 3.80 | 1.76 | 10.24 | 10. | 8.48 | 8. | 9.65 | 2.12 | 2. | 1.91 | 5520 |
| †5487 | Cumberland Guano .... .......... | .... | .... | 1.33 | 1.33 | 1.03 | 3.72 | 5.36 | 3.76 | 1.79 | 10.91 | 10. | 9.12 | 8. | 10.37 | 2.12 | 2. | 1.91 | 5487 |
| *†5486 | Cumberland Potato Fertilizer...... | 0.19 | .... | 2.05 | 2.24 | 2.06 | 6.27 | 5.60 | 3.51 | 2.92 | 12.03 | 11. | 9.11 | 9. | 10.84 | 3.30 | 3. | 2.97 | 5486 |
| *†5508 | Cumberland Seeding Down...... | .... | .... | 1.29 | 1.29 | 1.03 | 3.61 | 5.49 | 3.03 | 2.04 | 10.56 | 10. | 8.52 | 8. | 9.89 | 2.00 | 2. | 1.80 | 5508 |
| *†5305 | Cumberland Superphosphate....... | .... | 0.12 | 2.12 | 2.24 | 2.06 | 6.26 | 5.72 | 3.73 | 2.30 | 11.75 | 10. | 9.45 | 8. | 10.94 | 1.93 | 2. | 1.74 | 5305 |
| †5286 | Great Eastern Corn Phosphate ..... | .... | 0.29 | 2.75 | 3.04 | 3. | 3.48 | 6.96 | 1.60 | 1.39 | 9.95 | 9. | 8.56 | 8. | 9.81 | 2.41 | 2. | 2.17 | 5286 |
| †5298 | Great Eastern General Fertilizer ... | 0.11 | .... | 0.97 | 1.08 | 0.82 | 3.02 | 6.49 | 1.62 | 1.28 | 9.39 | 9. | 8.11 | 8. | 9.27 | 4.13 | 4. | 3.72 | 5298 |
| †5294 | Great Eastern Grass and Oats Fert.. | .... | .... | .... | .... | ... | .... | 6.76 | 4.22 | 2.02 | 13.00 | 12. | 10.98 | 11. | 12.46 | 2.12 | 2. | 1.91 | 5294 |
| †5292 | Great Eastern Potato Manure....... | .... | .... | 2.13 | 2.13 | 2.06 | 5.96 | 6.39 | 2.07 | 2.14 | 10.60 | 9. | 8.46 | 8. | 9.96 | 4.21 | 4. | 3.79 | 5292 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5493 | Lister's Animal Bone and Potash.... | .... | ... | .... | .... | ... | $... | 6.62 | 2.84 | 0.94 | **10.40** | *10.* | **9.46** | *9.* | $10.50 | **5.12** | *5.* | $4.61 | 5493 |
| 5426 | Lister's Animal Bone & Potash No. 2 | .... | .... | .... | .... | .. . | .... | 4.78 | 5.63 | 1.01 | **11.42** | *1.* | **10.41** | *10.* | 11.29 | **3.28** | *3.* | 2.95 | 5426 |
| 5524 | Lister's Harvest Queen Phosphate.. | .... | 0.24 | 1.19 | **1.43** | *1.24* | 3.98 | 7.70 | 2.61 | 2.45 | **12.76** | *11.5* | **10.31** | *9.5* | 12.06 | **2.12** | *2.* | 1.91 | 5524 |
| 5167 | Lister's Perfect Fertilizer.......... | .... | 0.26 | 1.38 | **1.64** | *1.24* | 4.57 | 7.49 | 3.05 | 2.33 | **12.87** | *11.5* | **10.54** | *9.5* | 12.22 | **2.19** | *2.* | 1.97 | 5167 |
| 5542 | Lister's Potato Manure.... ........ | .... | 1.54 | 2.17 | **3.71** | *3.7* | 10.23 | 6.95 | 1.91 | 1.33 | **10.19** | *8.5* | **8.86** | *7.5* | 10.09 | **7.46** | *7.* | 6.71 | 5542 |
| 5539 | Lister's Potato Fertilizer No. 2...... | .... | 0.20 | 1.71 | **1.91** | *1.81* | 5.33 | 8.04 | 2.33 | 1.81 | **11.68** | *12.* | **10.37** | *9.25* | 11.70 | **4.50** | *4.* | 4.05 | 5539 |
| 5290 | Lister's Special Potato Fertilizer..... | .... | 0.21 | 1.54 | **1.75** | *1.65* | 4.88 | 6.47 | 2.84 | 2.53 | **11.64** | *9.* | **9.31** | *8.* | 10.89 | **3.82** | *3.* | 3.44 | 5290 |
| †5283 | Lister's Success Fertilizer.......... | .... | 0.22 | 1.32 | **1.54** | *1.24* | 4.29 | 7.59 | 3.96 | 2.11 | **13.66** | *11.5* | **11.55** | *9.5* | 13.15 | **2.21** | *2.* | 1.99 | 5283 |
| 5194 | Lister's U. S. Superphos........ ... | .... | 0.24 | 1.24 | **1.48** | *1.32* | 4.12 | 5.81 | 3.38 | 2.26 | **11.45** | *8.* | **9.19** | *7.* | 10.68 | **2.69** | *2.* | 2.42 | 5194 |
| 5434 | Lowell Animal Brand.. ...... .... | .... | .... | 2.58 | **2.58** | *2.47* | 7.22 | 6.98 | 3.95 | 1.84 | **12.77** | *10.* | **10.93** | *9.* | 12.36 | **3.91** | *4.* | 3.52 | 5434 |
| †5229 | Lowell Bone Fertilizer............ | .... | .... | 1.80 | **1.80** | *1.65* | 5.04 | 4.39 | 3.03 | 1.96 | **9.38** | *9.* | **7.42** | *8.* | 8.64 | **2.80** | *3.* | 2.52 | 5229 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. Found. | Total. Guaranteed. | Available. Found. | Available. Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| 5188 | Lowell Dissolved Bone and Potash | .... | .... | 1.68 | **1.68** | *1.65* | $4.70 | 4.11 | 3.73 | 2.17 | **10.01** | *10.* | **7.84** | *9.* | $ 9.12 | **2.38** | *2.* | $2.14 | 5188 |
| 5433 | Lowell Complete Manure for Veg'ble | .... | .... | 2.24 | **2.24** | *2.06* | 6.27 | 5.79 | 5.09 | 3.04 | **13.92** | *9.* | **10.88** | *8.* | 12.68 | **3.41** | *3.5* | 3.07 | 5433 |
| ‡†5507 | Lowell Empire Brand | .... | .... | 1.29 | **1.29** | *1.23* | 3.61 | 2.89 | 2.94 | 1.86 | **7.69** | *8.* | **5.83** | *7.* | 6.86 | **2.46** | *2.* | 2.21 | 5507 |
| 5523 | P. G. Co.'s Nobsque Guano | .... | .... | 1.32 | **1.32** | *1.15* | 3.70 | 5.69 | 2.80 | 1.54 | **10.03** | *9.* | **8.49** | *8.* | 9.68 | **2.25** | *2.* | 2.02 | 5523 |
| †5306 | P. G. Co.'s Soluble Pacific Guano | .... | .... | 2.37 | **2.37** | *2.25* | 6.64 | 6.54 | 2.74 | 1.94 | **11.22** | *10.5* | **9.28** | *8.5* | 10.71 | **1.93** | *2.* | 1.74 | 5306 |
| †5483 | P. G. Co.'s Spcl. Potato and Tobacco | 0.17 | .... | 2.03 | **2.20** | *2.06* | 6.16 | 5.64 | 3.25 | 2.66 | **11.55** | *9.* | **8.89** | *8.* | 10.52 | **3.34** | *3.* | 3.01 | 5483 |
| †5256 | P. & P. Co.'s Plymouth Rock Brand | 0.32 | .... | 2.35 | **2.67** | *2.47* | 7.43 | 4.88 | 4.09 | 1.45 | **9.92** | *9.* | **8.47** | *8.* | 9.49 | **4.24** | *4.* | 3.82 | 5256 |
| †5257 | P. & P. Co.'s Star Brand Superphos | .... | .... | 1.91 | **1.91** | *1.64* | 5.35 | 4.19 | 4.62 | 1.32 | **10.13** | *8.* | **8.81** | *7.* | 9.76 | **2.64** | *2.5* | 2.38 | 5257 |
| †5491 | Quinnipiac Climax Phosphate | .... | .... | 1.29 | **1.29** | *1.03* | 3.61 | 5.40 | 2.98 | 1.72 | **10.10** | *9.* | **8.38** | *8.* | 9.61 | **2.23** | *2.* | 2.01 | 5491 |
| †5282 | Quinnipiac Corn Manure | 0.11 | 0.18 | 2.01 | **2.25** | *2.06* | 6.29 | 5.22 | 3.79 | 2.15 | **11.16** | *10.* | **9.01** | *9.* | 10.39 | **1.77** | *1.5* | 1.59 | 5282 |
| 5455 | Quinnipiac Market Garden Manure | .... | 0.95 | 2.37 | **3.32** | *3.3* | 9.20 | 5.17 | 4.46 | 1.22 | **10.85** | *9.* | **9.63** | *8.* | 10.64 | **6.66** | *7.* | 5.99 | 5455 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58. ‡Reverted and available phosphoric acids and "valuation of phosphoric acid" in this brand were incorrectly given in Bulletin 58 as 3.96 and 6.83 per cent. and $7.86 respectively.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | Nitrogen. | | | | | | Phosphoric Acid. | | | | | | | | Potash. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. | | Available. | | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| | | | | | | | | | | | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| 5538 | Quinnipiac Phosphate………… …. | 0.21 | …. | 2.36 | **2.57** | *2.47* | $7.20 | 5.48 | 5.44 | 1.46 | **12.38** | *10.* | **10.92** | *9.* | $12.05 | **2.02** | *2.* | $1.82 | 5538 |
| 5332 | Quinnipiac Pine Island Phosphate.. | …. | …. | 2.22 | **2.22** | *2.06* | 6.22 | 6.86 | 2.54 | 1.40 | **10.80** | *10.* | **9.40** | *9.* | 10.65 | **2.25** | *1.* | 2.02 | 5332 |
| 5469 | Quinnipiac Potato Manure………. | … | …. | 2.48 | **2.48** | *2.47* | 6.94 | 4.75 | 2.68 | 1.70 | **9.13** | *7.* | **7.43** | *6.* | 8.59 | **5.38** | *5.* | 4.84 | 5469 |
| †5289 | Quinnipiac Potato Phosphate…. .. | 0.10 | …. | 2.37 | **2.47** | *2.05* | 6.92 | 6.18 | 2.87 | 2.37 | **11.42** | *9.* | **9.05** | *8.* | 10.62 | **3.64** | *3.* | 3.28 | 5289 |
| 5452 | Quinnipiac Seeding Down Fertilizer | … | …. | 1.21 | **1.21** | *0.82* | 3.39 | 6.16 | 2.60 | 1.51 | **10.27** | *10.* | **8.76** | *9.* | 9.98 | **2.40** | *2.* | 2.16 | 5452 |
| 5547 | Read's Corn and Wheat Mixture… | … | …. | 1.15 | **1.15** | *0.83* | 3.22 | 5.91 | 3.22 | 1.09 | **10.22** | *9.* | **9.13** | *8.* | 10.16 | **1.21** | *1.* | 1.09 | 5547 |
| †5501 | Read's Farmers' Friend Superphos. | …. | … | 2.25 | **2.25** | *2.06* | 6.80 | 6.97 | 2.67 | 1.02 | **10.66** | *10.* | **9.64** | *9.* | 10.75 | **2.27** | *2.* | 2.04 | 5501 |
| †5503 | Read's Fish, Bone and Potash…… | …. | 0.26 | 2.48 | **2.74** | *2.47* | 7.64 | 3.11 | 1.36 | 1.09 | **5.56** | *5.* | **4.47** | *4.* | 5.22 | **4.50** | *4.* | 4.05 | 5503 |
| †5502 | Read's Leader Guano….. ……… | … | …. | 1.10 | **1.10** | *0.82* | 3.08 | 5.50 | 1.96 | 0.95 | **8.41** | *8.* | **7.46** | *7.* | 8.39 | **2.73** | *2.* | 2.46 | 5502 |
| †5499 | Read's Practical Potato Special….. | …. | …. | 1.09 | **1.09** | *0.82* | 3.05 | 2.51 | 1.98 | 1.31 | **5.80** | *5.* | **4.49** | *4.* | 5.27 | **8.29** | *8.* | 7.46 | 5499 |
| 5356 | Read's Prime Wheat and Rye Fert. | …. | …. | 2.03 | **2.03** | *1.64* | 5.68 | 6.53 | 2.17 | 0.93 | **9.63** | *9.* | **8.70** | *8.* | 9.78 | **4.31** | *4.* | 3.88 | 5356 |
| †5488 | Read's Standard Superphosphate.. | … | …. | 1.15 | **1.15** | *0.82* | 3.22 | 6.14 | 2.09 | 1.11 | **9.34** | *9.* | **8.23** | *8.* | 9.29 | **3.36** | *4.* | 3.02 | 5488 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate ; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| †5500 | Read's Sure Catch Fertilizer | .... | .... | .... | .... | .. | $... | 5.45 | 2.30 | 0.86 | **8.61** | *7.* | 7.75 | *6.* | $ 8.64 | **5.14** | *4.* | $4.68 | 5500 |
| †5498 | R. C. Co.'s Essex Complete Corn, &c. | 0.94 | .... | 3.18 | **4.07** | *3.7* | 11.40 | 3.51 | 5.56 | 2.61 | **11.68** | *9.5* | **9.07** | *7.* | 10.47 | **9.88** | *9.5* | 8.89 | 5498 |
| *5514 | R. C. Co.'s Essex Comp., Pot., R'ts&c | .... | 1.09 | 3.27 | **4.36** | *3.7* | 12.10 | 3.36 | 5.40 | 1.92 | **10.68** | *10.* | **8.76** | *7.* | 9.86 | **9.08** | *8.5* | 9.01 | 5514 |
| †5490 | R. C. Co.'s Essex XXX Fish & Pot. | .... | .... | 2.65 | **2.65** | *2.1* | 7.42 | 4.02 | 5.89 | 3.81 | **13.72** | *11.* | **9.91** | *10.* | 11.84 | **2.55** | *2.25* | 2.29 | 5490 |
| 5515 | R. C. Co.'s High Grade Superphos | 0.61 | .... | 2.37 | **2.98** | *2.5* | 8.84 | 3.49 | 7.04 | 3.33 | **13.86** | *11.* | **10.53** | *9.* | 12.21 | **4.72** | *4.* | 4.25 | 5515 |
| †5277 | Standard Fertilizer | .... | .... | 2.18 | **2.13** | *2.06* | 5.96 | 5.74 | 3.84 | 1.98 | **11.51** | *10.* | **9.58** | *8.* | 10.98 | **1.92** | *2.* | 1.78 | 5277 |
| 5543 | Standard Guano | .... | .... | 1.28 | **1.28** | *1.03* | 3.58 | 5.40 | 3.30 | 1.86 | **10.56** | *10* | **8.70** | *8.* | 9.98 | **2.17** | *2.* | 1.95 | 5543 |
| 5522 | Standard Potato and Tobacco Fert | .... | .... | 2.12 | **2.12** | *2.05* | 5.94 | 5.81 | 4.22 | 2.65 | **12.18** | *9.* | **9.53** | *8.* | 11.12 | **2.92** | *3.* | 2.63 | 5522 |
| 5885 | Standard Superphosphate | .... | .... | 2.68 | **2.68** | *2.5* | 7.50 | 6.04 | 4.04 | 1.98 | **12.06** | *11.* | **10.08** | *9.* | 11.48 | **2.03** | *2.* | 1.88 | 5885 |
| †5296 | Tucker's Imperial Bone Superphos | .... | .... | 2.16 | **2.16** | *1.* | 6.05 | 4.19 | 4.26 | 2.50 | **10.95** | *11.* | **8.45** | *9.* | 9.87 | **2.07** | *1.85* | 1.86 | 5296 |
| †5509 | Tucker's Imperial for Corn | .... | ... | 2.12 | **2.12** | *1.* | 5.94 | 4.79 | 4.18 | 2.48 | **11.40** | *11.* | **8.97** | *9.* | 10.42 | **1.92** | *1.85* | 1.73 | 5509 |
| †5810 | Tucker's Imperial for Potatoes | 0.30 | .... | 1.88 | **2.13** | *1.* | 5.96 | 5.18 | 3.88 | 2.14 | **11.15** | *11.* | **9.01** | *9.* | 10.38 | **2.02** | *1.85* | 1.82 | 5810 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. †Reprinted from Bulletin 58.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton. | Soluble. | Reverted. | Insoluble. | Total. | | Available. | | Valuation of Phosphoric Acid in One Ton. | Found. | Guaranteed. | Valuation of Potash in One Ton. | |
| | | | | | | | | | | | Found. | Guaranteed. | Found. | Guaranteed. | | | | | |
| †5496 | W. & C. Co.'s Amer. Ammo. Bone | .... | .... | 2.55 | **2.55** | *2.47* | $7.14 | 6.51 | 3.66 | 2.28 | **12.45** | *10.* | **10.17** | *9.* | $11.73 | **1.82** | *2.* | $1.64 | 5496 |
| †5295 | W. & C. Co,'s Americus Corn Phos | .... | .... | 2.36 | **2.36** | *2.06* | 6 61 | 6.47 | 2.88 | 2.07 | **11 42** | *10.* | **9.35** | *9.* | 10.83 | **1.65** | *1.5* | 1.48 | 5295 |
| 5521 | W. & C. Co.'s Amer. Potato Phos | .... | .... | 2.50 | **2 50** | *2.47* | 7.00 | 4.69 | 2.41 | 2.03 | **9.13** | *7.* | **7.10** | *6.* | 8.88 | **5.51** | *5.* | 4.96 | 5521 |
| †5284 | W. & C. Co.'s Ammo. Potato and Tob | 0.10 | ... | 2.19 | **2.29** | *2.06* | 6.41 | 5.88 | 3.15 | 2.39 | **11.42** | *9.* | **9.03** | *8.* | 10.57 | **3.39** | *3.* | 3.05 | 5284 |
| 5086 | W. & C. Co.'s High Grade Special | .... | 0.95 | 2.52 | **3.47** | *3.7* | 9.62 | 5.30 | 3 68 | 1.23 | **10 21** | *8.* | **8 98** | *7.* | 10.00 | **7.08** | *7.* | 6.38 | 5086 |
| †5288 | W. & C. Co.'s Royal Bone Phosphate | .... | .... | 1.36 | **1.36** | *1.03* | 3.81 | 5.34 | 3.40 | 1.88 | **10.62** | *8.* | **8.74** | *7.* | 10.03 | **2.25** | *2.* | 2.02 | 5288 |
| *5560 | B. C. B. A., M. S. G. Corn, Etc. | 0.21 | .... | 2.25 | **2.46** | *3.29* | 6.89 | 0.10 | 8.15 | 4 39 | **12 64** | .... | **8.25** | *7.* | 10.02 | **6.65** | *7.* | 6.59 | 5560 |
| *5561 | B. C. B. A., M. S. G. General | 0.21 | .... | 2.12 | **2.33** | *2.47* | 6.52 | 0.10 | 5.37 | 5.18 | **10.65** | .... | **5.47** | *7.* | 7.55 | **3.94** | *4.* | 3.78 | 5561 |
| *5559 | B. C. B. A., M. S. G. Pot. and Veg. | 0.18 | 0.11 | 2.93 | **3.22** | *3.29* | 9.02 | 0.18 | 6.70 | 3.05 | **9.93** | .... | **6.88** | *6.* | 8.12 | **8.51** | *8.* | 8.31 | 5559 |
| 5558 | B. C. B. A., M. S. G. Superphos. | 0.51 | 0.21 | 1.26 | **1.98** | *1.64* | 5.54 | 0.08 | 5.40 | 5.19 | **10.67** | .... | **5.48** | *6.* | 7.56 | **2.13** | *2.* | 1.92 | 5558 |
| 5562 | B. C. B. A., M. S. G. Top Dressing | 1.81 | .... | 1.54 | **3.35** | *4.12* | 9.88 | 0.02 | 4.82 | 2.88 | **7.72** | .... | **4.84** | *4.* | 5.99 | **7.42** | *6.* | 6.68 | 5562 |
| ‡5557 | Bowker's Vermont Phosphate | 0.58 | .... | 1.86 | **2.44** | *1.75* | 6.83 | 6.55 | 2.16 | 1.17 | **9.88** | *10.* | **8.71** | *8.* | 9.83 | **4.09** | *3.* | 3.68 | 5557 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such. † Reprinted from Bulletin 58. ‡ Sample taken at request of manufacturers from later shipments than those making Station number 5494.

## V. COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1896 AND IN 1897.

Of the 151 brands of commercial fertilizers sold in the State during 1896 and 1897, and found by our sampling agents, 94 have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands have been chosen which have been found by us both years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1896 AND 1897.

| Name of Ingredient. | 1896. | | 1897. | |
|---|---|---|---|---|
| | Pounds in a hundred. | Valuation at 1897 prices. | Pounds in a hundred. | Valuation at 1897 prices. |
| Nitrogen | 2.20 | $6.16 | 2.12 | $5.94 |
| Soluble Phosphoric Acid | 5.41 | 5 95 | 5.66 | 6.23 |
| Reverted Phosphoric Acid | 3.34 | 3.34 | 3.32 | 3.32 |
| Insoluble Phosphoric Acid | 2.27 | 0.91 | 2.15 | 0.86 |
| Available Phosphoric Acid | 8.75 | | 8.98 | |
| Total Phosphoric Acid | 11.02 | | 11.13 | |
| Potash | 3.41 | 3.07 | 3.31 | 2.98 |
| Total valuation per ton | | $19.43 | | $19.33 |

A comparison of the average composition of these 94 brands as sold during 1896 and 1897 betrays but slight differences. The goods of the current year were a tenth lower in two ingredients (nitrogen and potash), two tenths higher in one ingredient (available phosphoric acid) and "value" ten cents less. There has been a sharp cut in the selling prices of mixed goods this year however, the average cost being $1.71 per ton less than was asked in 1896. It follows therefore that the average cost of plant food was less this year than it was last.

In this connection the following table showing the average of analyses, selling prices, valuations, percentages of increase of cost over valuation, and valuations of all at 1897 trade values may prove helpful. All brands analyzed each year since the Station has had charge of this class of work are included in the comparison, each brand being given equal value, which, while not strictly a correct method of calculation, is the best which can be done in the absence of data showing the consumption of individual brands.

### AVERAGE ANALYSES OF ALL BRANDS.

| | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | 2.38 | 2.58 | 2.75 | 2.80 | 2.55 | 2.41 | 2.52 | 2.42 | 2.41 | 2.21 | 2.22 | 2.22 | 2.12 |
| Soluble Phos. Acid | 6.35 | 6.15 | 5.48 | 6.74 | 6.68 | 5.99 | 6.47 | 6.47 | 6.44 | 5.42 | 5.84 | 5.36 | 5.34 |
| Reverted Phos. Acid | 1.93 | 1.92 | 3.23 | 2.80 | 2.97 | 2.97 | 2.86 | 2.60 | 2.84 | 2.97 | 2.56 | 3.44 | 3.68 |
| Insoluble Phos. Acid | 2.13 | 2.59 | 2.52 | 2.56 | 2.98 | 2.71 | 2.00 | 2.18 | 2.34 | 2.16 | 2.53 | 2.22 | 2.23 |
| Available Phos. Acid | 8.28 | 8.07 | 8.71 | 9.54 | 9.65 | 8.96 | 9.33 | 9.07 | 9.28 | 8.39 | 8.40 | 8.80 | 9.02 |
| Total Phos. Acid | 10.41 | 10.66 | 11.23 | 12.10 | 12.63 | 11.67 | 11.33 | 11.25 | 11.62 | 10.55 | 10.93 | 11.02 | 11.25 |
| Potash | 2.77 | 2.69 | 2.84 | 3.12 | 2.69 | 3.16 | 3.13 | 2.82 | 2.64 | 2.95 | 3.46 | 3.66 | 3.43 |
| | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ | $ |
| Average selling price | 37.90 | 37.02 | 36.75 | 35.18 | 35.11 | 34.39 | 33.14 | 32.47 | 32.32 | 31.47 | 30.90 | 30.90 | 29.19 |
| Average valuation by each year's price | 26.72 | 25.75 | 27.15 | 28.96 | 29.05 | 26.70 | 26.07 | 24.48 | 23.53 | 21.47 | 21.28 | 19.73 | 19.47 |
| Per cent. increase of cost over valuation | 42. | 44. | 35. | 21. | 21. | 29. | 27. | 33. | 37. | 47. | 45. | 57. | 50. |
| Valuation by '97 prices | 18.92 | 19.37 | 20.53 | 21.89 | 21.07 | 20.26 | 20.65 | 19.91 | 19.99 | 18.63 | 19.32 | 19.73 | 19.47 |

If six samples of non-nitrogenous superphosphates with potash be excluded, the nitrogen average in the 1897 goods equals that of 1896, available phosphoric acid is lowered 0.05 per cent., potash remains unchanged and "valuation" becomes $19.69. The lessened selling prices have resulted in making the most favorable showing in the matter of cheap plant food of any year since the Station has had charge of the fertilizer control. Better goods were sold from 1887 to 1893 but cost from $3.00 to $7.50 more per ton. Plant food is cheaper to the Vermont farmer than ever before. It is cheaper, however, not because manufacturers as a class are selling closer but because of the lessened cost of crude stock or raw materials which enter into the manufacture of the goods. It follows therefore that those who practice home mixing can now as in years past in many cases save considerable amounts as compared with the direct purchase of factory mixed goods.

## VI. ANALYSES OF MISCELLANEOUS FERTILIZERS.

### HOME MIXED FERTILIZERS, CRUDE STOCKS, ETC.

| Station Number. | MATERIAL AND SOURCE. | NITROGEN. | PHOSPHORIC ACID. Soluble. | PHOSPHORIC ACID. Reverted. | PHOSPHORIC ACID. Insoluble. | PHOSPHORIC ACID. Total. | PHOSPHORIC ACID. Available. | POTASH. |
|---|---|---|---|---|---|---|---|---|
| | **HOME MIXTURES, ETC.** | | | | | | | |
| 5005 | A. N. Bliss, Calais | .... | 0.29 | 3.47 | 15.54 | 19.30 | 3.76 | 5.94 |
| 5006 | Rutland Fire Clay Co., Rutland; "Plantene" | 5.04 | 9.84 | 0.21 | 0.19 | 10.24 | 10.05 | 7.38 |
| *5011 | C. A. Hutchinson, East Peacham | 3.93 | 2.42 | 1.86 | 1.89 | 6.17 | 4.28 | 10.62 |
| †5012 | C. A. Hutchinson, East Peacham | 2.54 | 8.76 | 1.79 | 2.14 | 12.69 | 10.55 | 7.11 |
| 5018 | E. A. Smith, Woodstock | 3.22 | 8.91 | 2.06 | 1.12 | 12.09 | 10.97 | 4.51 |
| 5019 | J. O. Sanford, Stamford | 2.63 | 6.43 | 2.18 | 0.84 | 9.45 | 8.61 | 11.66 |
| 5022 | ........ | 2.91 | 0.00 | 6.66 | 8.31 | 14.97 | 6.66 | 0.66 |
| ‡5027 | W. S. Allen, Jacksonville | 2.58 | 4.75 | 6.19 | 1.63 | 12.57 | 10.94 | 1.94 |
| ¶5028 | W. S. Allen Jacksonville | 3.59 | 7.30 | 3.99 | 1.12 | 12.41 | 11.29 | 4.25 |
| | **DISSOLVED BONE BLACK AND ACID PHOSPHATE.** | | | | | | | |
| 5009 | D. B. B.; C. A. Hutchinson, East Peacham | | 11.29 | 3.40 | 2.36 | 18.05 | 15.69 | |
| 5407 | D. B. B., (Bradley); H. L. Templeton, Montpelier | | 9.09 | 6.32 | 1.44 | 16.85 | 15.41 | |
| 5016 | A. P., (Coe); Experiment Station | | 9.27 | 2.98 | 3.25 | 15.50 | 12.25 | |
| 5023 | A. P., (Bowker); J. O. Sanford, Stamford | | ‖ | ‖ | 1.73 | 16.28 | 14.55 | |
| 5477 | A. P., (W. & C. Co.); C. A. Hinsdill, No. Bennington | | 5.28 | 8.72 | 3.51 | 17.51 | 14.00 | |
| 5550 | A. P., (Crocker); Experiment Station | | 12.95 | 3.82 | 1.99 | 18.76 | 16.77 | |
| | **NITRATE OF SODA AND TANKAGE.** | | | | | | | |
| 5021 | Nit. Soda (Bowker); J. O. Sanford, Stamford | | 15.54 | | | | | |
| 5478 | Nit. Soda (W & C. Co.); C. A. Hinsdill, No. Bennington | | 15.74 | | | | | |
| 5409 | Nit. Soda (Bradley); H. L. Templeton, Montpelier | | 15.43 | | | | | |
| 5551 | Nit. Soda (Crocker); Experiment Station | | 15.85 | | | | | |
| 5010 | Tankage; C. A. Hutchinson, East Peacham | | 7.23 | | | 10.78 | | |
| 5040 | Tankage } Robertson & Shiland, Burlington. | | 5.29 | | | 16.16 | | |
| 5041 | | | 4.52 | | | 15.60 | | |
| 5042 | | | 3.31 | | | 13.11 | | |

Nos. 5005, 5011, 5012, 5018, and 5022 were home mixtures, made from crude stock by the parties named, and compared favorably in chemical composition and mechanical condition with the better class of mixed goods as found on the market. So far as heard from the mixtures gave good results in the field. Parties desiring information regarding home mixing should apply for Bulletin 47.

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* For Corn. † For Potash. ‡ Bradley's XL, 1896 goods. ¶ Bowker's Stockbridge Corn, 1896 goods. ‖ Not determined.

| Station Number. | MATERIAL AND SOURCE. | Mechanical Analysis. | | | Nitrogen. | Total Phosphoric Acid. | Potash. |
|---|---|---|---|---|---|---|---|
| | | Finer than 1-50 inch. | Finer than 1-25 inch. | Coarser than 1-25 inch. | | | |
| | **GROUND BONE.** | | | | | | |
| 5563 | American F. Co.'s Ground Bone; M. J. Holt, So. Woodstock | 53 | 23 | 24 | 3.77 | 17.82 | |
| 5374 | Lister's Increase Crescent Bone Dust; J. K. Curtis, St. Albans | 44 | 26 | 30 | 2.81 | 15.06 | |
| 5375 | Lister's Pure Raw Bone Meal; J. K. Curtis, St. Albans | 55 | 27 | 18 | 2.87 | 24.06 | |
| 5260 | Bradley's Fine Ground Bone; Brooks & Berry, Montpelier | 66 | 19 | 15 | 2.45 | 21.12 | |
| 5417 | Bowker's Market Bone; Norman Davis, Woodstock | 86 | 9 | 4 | 2.62 | 20.58 | |
| | **MURIATE OF POTASH.** | | | | | | |
| 5007 | .................. C. W. Webster, East Roxbury........ | | | | | | 51.26 |
| 5013 | .................. C. A. Hutchinson, East Peacham...... | | | | | | 51.94 |
| 5015 | E. F. Coe Co.; Experiment Station..................... | | | | | | 51.19 |
| 5020 | Bowker; J. O. Sanford, Stamford......................... | | | | | | 49.40 |
| 5476 | W. & C. Co.; C. A. Hinsdill, North Bennington........ | | | | | | 50.17 |
| 5552 | Crocker; Experiment Station.............................. | | | | | | 52.01 |
| | **SULPHATE OF POTASH, ETC.** | | | | | | |
| 5014 | E. F. Coe Co.; Experiment Station...................... | | | | | | 50.80 |
| 5553 | Crocker; Experiment Station ............................... | | | | | | 51.34 |
| 5408 | Double Manure Salt. Bradley; H. L. Templeton, Montpelier. | | | | | | 25.00 |
| 5480 | Sylvanite. Read; Gove & Taylor. Burlington......... | | | | | | 19.33 |

## ANALYSES OF MUCK.

| Station Number. | Received From. | ORIGINAL SUBSTANCE. | | | | DRY MATTER. | | |
|---|---|---|---|---|---|---|---|---|
| | | Moisture. | Ash. | Organic and Volatile Matter. | Nitrogen. | Ash. | Organic and Volatile Matter. | Nitrogen. |
| 5024 | H. G. Thompson, Pawlet ...... ...... | 61.66 | 6.90 | 31.44 | 1.19 | 17.99 | 82.01 | 3.10 |
| 5025 | D. C. Wright, Westminster Station. | 36.08 | 9.28 | 54.71 | 1.35 | 14.50 | 85.50 | 2.11 |
| 5026 | Louise C. Hunt, Fairfax.... ....... .... | 16.40 | 30.18 | 53.42 | 1.63 | 36.10 | 63.90 | 1.95 |
| 5032 | U. C. Bradley, Warren........... .... | 85.03 | 5.25 | 9.71 | 0.25 | 35.13 | 64.87 | 1.67 |
| 5035 | E. K. Gray, Coventry.................. | 10.15 | 21.45 | 68.05 | 1.65 | 23.97 | 76.03 | 1.84 |
| 5036 | C. de Nottbeck, Dorset...... .... .... | 50.97 | 35.50 | 13.53 | 0.49 | 71.21 | 28.79 | 1.04 |
| 5038 | C. de Nottbeck, Dorset...... ....... .... | 71.40 | 15.09 | 13.51 | 0.53 | 52.75 | 47.25 | 1.71 |
| 5014 | H. B. Chapin, Middlesex ....... ...... | 28.91 | 8.99 | 62.10 | 1.10 | 12.64 | 87.36 | 1.55 |
| 5512 | M. S. Thomas. Isle LaMotte.......... | 70.47 | 3.75 | 25.78 | 0.92 | 12.70 | 87.30 | 3.13 |

**Nine samples of muck varied from 1.04 to 3.13 per cent. of nitrogen. Nos. 5024 and 5512 are the best mucks thus far analyzed at this Station.**

## ANALYSES OF ASHES.

| Station Number. | Source. | Received From. | Soluble Potash. | Insoluble Potash. | Total Potash. | Total Phosphoric Acid. | Insoluble Matter. |
|---|---|---|---|---|---|---|---|
| 5002 | | W. V. Farr, Westminster Station | 5.81 | 1.29 | 7.10 | 1.48 | |
| 5003 | | W. V. Farr, Westminster Station | 5.10 | 1.00 | 6.10 | 1.28 | |
| 5004 | | F. J. LePierre, Burlington | 8.01 | 0.89 | 8.90 | 1.54 | |
| 5030 | Hard wood | U. C. Bradley, Warren | 8.19 | 0.77 | 8.96 | 1.78 | |
| 5031 | Soft wood | U. C. Bradley, Warren | 4.23 | 1.88 | 6.11 | 2.98 | |
| 5034 | | LeG. B. Cannon, Burlington | 5.05 | 0.23 | 5.28 | 1.57 | |
| 5039 | | C. G. Miller, Westminster | 2.45 | 2.57 | 5.02 | 1.29 | 34.14 |
| 5043 | | W. V. Farr, Westminster | 4.92 | 1.95 | 6.87 | 3.93 | |
| 5046 | | E. A. Smith, Woodstock | 6.59 | 1.13 | 7.72 | 2.53 | 11.59 |
| 5510 | | W. P. White, East Ryegate | 8.21 | 2.59 | 10.80 | 5.00 | 3.63 |
| 5511 | Lime-Kiln | G. W. Shepard, South Fairfax | 3.48 | 0.37 | 3.85 | 1.08 | 2.96 |

Eleven samples of ashes have been analyzed during the past year. They varied from 2.45 to 8.21 per cent. soluble potash, and from 1.08 to 5.00 per cent. total phosphoric acid. The beneficial effects of ashes are quite as often due to the lime which they contain as to the potash. There are not such wide variations in this ingredient, however, as are found in the potash. It is probably safe to say that the goods represented by No. 5510 are worth twice and perhaps thrice those represented by No. 5039. The price of this class of foods is seldom proportionate to quality. It is wise, therefore, to buy subject to analysis. Reputable dealers will usually allow a discount in case Station analysis shows deficiency.

**5008. Harvester Fertilizer**; manufactured by Harvester Fertilizer Co., Mechanicsville, N. Y.; from stock of F. Johnson, West Pawlet, contained no nitrogen, no phosphoric acid, 0.14 per cent. potash. About three-quarters of its weight consisted of ground lime-stone, it "valued" at thirteen cents a ton and it sold for nine dollars a ton. Sales were not in violation of the State law which exempts goods selling for less than ten dollars a ton from inspection and from the necessity of guaranteeing composition.

**5017. Cremation Ashes.** G. W. Allen, Essex Junction. These ashes were a mixture of wood ashes and bone, the result of burning the carcasses of about thirty-five tuberculous cattle. They contained total phosphoric acid, 21.24 per cent; potash, 2.72 per cent.

**5045. Cotton Waste.** C. C. Read, Burlington. This material, the waste from cotton mills, contained 0.87 per cent. nitrogen, 0.15 per cent. phosphoric acid, and 0.95 per cent. potash. It absorbed 55 per cent. of its weight of liquid in three minutes time.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

# BULLETIN No. 60

OCTOBER, 1897

## Insects of the Year

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Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN NO. 60.—INSECTS OF THE YEAR.

By G. H. Perkins.

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## I. SUMMARY.

II. The army worm and the chinch bug which were serious pests in 1896 have not injured crops this season. Currant and cabbage worms, hornflies, railroad worms, aphides, &c., have been as usual quite troublesome. (Pages 4-5.)

III. The forest tent-caterpillar has been unusually abundant and destructive, especially to apple and sugar-maple trees, often wholly destroying the foliage. It has been widely distributed over the state. The eggs are laid in clusters about twigs in July, the larvæ hatch very early the following spring and are fully grown early in June when they are hairy worms, two inches long, of a dark blue color, marked by several longitudinal lines along the sides and a conspicuous row of light, oval spots along the middle of the back. They spin numerous silk threads and form a web which is not conspicuous. The adult, or moth, is a small yellowish insect.

The worms often cluster about the trunk of an infested tree and may be crushed. Sometimes when feeding they may be jarred from the branches and caught. Prevention is better than cure and the pests may be largely prevented by destroying the egg clusters when the trees are leafless in fall or winter. Emigration from tree to tree may be checked, if not prevented, by putting bands of tarred paper, or cloth, about the trunks. There are a few parasites which do much to check the increase of the insect. (Pages 5-9.)

IV. The oyster-shell scale of the apple has been very injurious in some orchards. All scales pass through great transformations from the egg to maturity and there are often vast differences between the males and females. The oyster-shell scale can be distinguished from others by its great length in proportion to its width. The minute eggs hatch into running larvæ, which, if females, soon form scales under which they are permanently fixed. In this position they injure the trees by sucking the sap. The best remedy is spraying with kerosene emulsion about the last of May and again early in June. (Pages 9-12.)

V. The San Jose scale has appeared in one place in the state. It is circular, quite small and of a grayish color. It is the worst pest among scales. It may be kept out of the state by vigilant inspection of plants or trees brought from outside and by prompt destruction of all that are infested. (Pages 12-14.)

VI. The round-headed apple-tree borer lays its eggs on the bark in early summer near the ground. The larvæ bore into the tree and live there three years when they come out as beetles. They may be cut out or destroyed by a pointed wire. The females may be prevented from laying their eggs, by a coat of strong alkaline wash or kerosene emulsion. The flat-headed borer does not confine itself so exclusively to the lower parts of the trees, but may lay its eggs anywhere, and is therefore harder to manage. Woodpeckers are very useful as they destroy the larvæ. (Pages 14-16.)

## II. INSECTS CAUSING MINOR DEPREDATIONS.

Although the past season has not been favorable to the unusual development of insects, since it has been cool and wet, yet a few species have been much more common than in past years. The customary and little noticed depredations of the always common species have been of the average sort and have been accepted by most farmers as a necessary evil. If, however, instead of submitting to these injuries as to the inevitable. the farmers would unitedly and persistently combat their insect enemies, the mischief done would be greatly diminished.

Very fortunately some insects which last year caused no little apprehension, have not fulfilled the gloomy forebodings which their ravages had caused, but have decreased and done little harm during the present season. Chief among these are the army worm and the chinch bug. The army worm has not attracted much attention and has committed no extensive ravages. The chinch bug, hitherto confined to a few limited areas in the state, has not spread over wider territory, nor has it become the scourge which it is capable of being and always is when it is present in large numbers. Many lesser pests have been reported as doing more or less damage. Currant worms, *Nematus ribesii*, and *Diastictis ribearia*, have been very troublesome in many gardens notwithstanding the well known remedies. The cabbage worm, *Pieris rapæ*, the horn fly, *Haematobia serrata*, and the carpet beetle, *Anthrenus scrophulariæ*, have been somewhat abundant. The larva of the common mourning-cloak butterfly, *Euranessa antiopa*, a spiny, dark-skinned caterpillar, with the body thickly dotted with white and with a row of eight dark red spots on the back, has attacked the elms and defoliated them in a few localities, but no general damage has been done. The red-humped caterpillar, *Œdemasia concinna*, which is sometimes troublesome on the apple, has been found in considerable numbers in one or two orchards. Oaks on Shelburne Point have suffered somewhat from the attacks of a moderate-sized spiny caterpillar of a general black color with two yellow stripes along each side and four on the back. This changes the next season into a yellow moth. This is the *Anisota senatoria*, which in other states has done much damage to the oak groves, completely stripping them of their foliage. Hence it is not impossible that it may become a serious pest in Vermont, but thus far it has not been found except in small numbers and over limited areas.

Perhaps the insects which have attracted most attention during the year have been the tent-caterpillars, *Clisiocampa americana*, and *C. disstria*, the oyster-shell bark-louse, *Mytilaspis pomorum*, the round-headed apple-tree borer, *Saperda candida*, various species of *Aphides*, or plant lice, and the railroad worm, *Trypeta pomonella*. As to the latter I am unable o suggest remedies other than those already mentioned.*

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*Rpt. Vt. Exp. Sta. (1893) p. 135.

One of the remedies proposed, that of turning swine into an orchard, has proved very efficient in many cases, as these animals root up and destroy larvæ of all sorts which may have taken refuge in the soil. There appears, however, to be some need of caution in the application of this remedy as Col. L. G. B. Cannon tells me that in one of his orchards the swine not only destroyed the larvae, but attacked the bark of many trees, tearing it off and greatly injuring them.

## III. TENT CATERPILLARS.

The common species of tent-caterpillar, *Clisiocampa americana*, was described and remedies suggested in Bulletin 11. I need only repeat here my belief that the presence of this insect is wholly unnecessary, and that with care and prompt use of remedies it may be controlled. The appearance of some orchards and some country roads during the past season has been a disgrace to our state.

The less known species *Clisiocampa disstria*, Hub. or forest tent-caterpillar is not so easily managed since it may flourish for some time in forests before it attracts attention, and then may suddenly migrate to adjacent orchards where it appears very unexpectedly in large swarms. So far as I am aware this insect has confined its ravages during the season to the apple and sugar maple and often to the latter. It appears to have been widely distributed over the state as it was reported from Rutalnd, Orwell, Springfield, Starksboro, Sharon, Manchester, Stowe, Waterbury and other towns. In most of the places named it was quite destructive. Mr. L. K. Osgood writes from Rutland, "Last year there were some sugar orchards that were entirely stripped of leaves. We did not notice the work until the leaves were full grown, and when the trees looked as though there had been a fire which had burned the leaves off. Some of the leaves had holes eaten through them, some were eaten off at the stem. It sounded in the woods as though it was raining quite hard from the falling leaves." Mr. F. Ochampaugh reports from Orwell, "From my factory I can see two large woods and one orchard that are stripped of all their leaves." Similar reports have come from Messrs. Timothy Wheeler of Moscow, F. H. Walker of Manchester, A. R. Nourse of Springfield and others. In some orchards the caterpillars are said to have been so numerous as almost to cover the trunks of the trees.

The forest tent-caterpillar sometimes occurs in astonishing numbers. It is stated that in 1887, trains on the Carolina Central railroad were stopped for three days by these worms which had crawled over the track and completely covered it so that the crushed bodies, acting like grease on the rails, caused the wheels of the locomotive to slip. The Department of Agriculture sent an expert entomologist to investigate this case and he found the statement quite true, and, moreover, reported that he saw miles of forest in which all the oaks and blue gums had been defoliated by the worms.*

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*Insect Life, Vol. III, p. 477.

A similar account of the stopping of trains by these caterpillars comes from Minnesota.

*Life history of the forest tent-caterpillar.*—The eggs are laid from the last of June to the middle of July, as the season is warm or cool. They are laid in circles about the twigs, first one, then closely pressed against it another, and so on until a compact cluster, as shown in figure 1, a, is formed. Each cluster contains on the average 400 eggs. The form of each egg is shown at d, in figure 1, and the form of the top at *c*, both greatly magnified. The eggs only about $\frac{1}{25}$ of an inch long, and are of a yellowish color. The eggs do not remain dormant, but develop during the summer so that in the fall they contain fully grown embryos, which do not leave the eggs are until spring. It is remarkable how these embryos are able to endure the cold and storms of winter and early spring. Even after leaving the eggs, which they do very early in the spring, the embryos are often compelled to endure freezing weather and also to fast for two, or even three weeks before the buds which furnish them food have opened sufficiently to allow them access to the leaves.

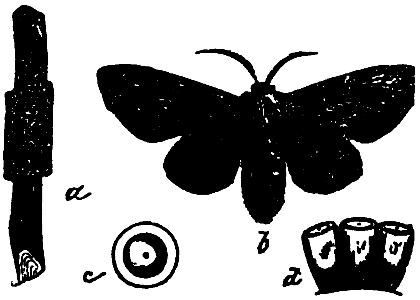

Fig. 1.

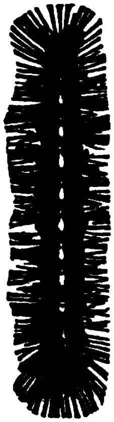

Fig. 2.

Figs. 1 and 2. *Clisiocampa disttria*, Fig. 1. (a) egg cluster, (b) female moth natural size, (c) top of egg, much magnified, (d) three eggs, Fig. 2, larva, natural size.

*The larvæ* when first hatched are minute black worms, usually creeping about in companies, and when moving some distance doing so in single file spinning silk threads along the path they traverse. In about two weeks they moult, the new skin being yellowish brown instead of black. By the end of another week the skin is changed a second time and the marking and colors of the mature larva appear, though less distinctly than after the third and last moult. The development from egg to mature larva requires about six weeks. The fully grown larva, figure 2, is a somewhat hairy worm, though less so than represented in the figure, about two inches long. In general appearance it resembles the common tent-caterpillar, but there are important and easily recognized differences. The body of the larva is bluish above changing on the sides to greenish, while underneath it is dark, the legs being nearly or quite black. The whole body is thickly sprinkled with black dots and several light longitudinal lines give distinct character to the coloring. The most conspicuous of all the markings is the line of ovate light spots along the back, behind each of which, (above as seen in figure 2,) is a small circular spot. Only nine of these are seen in the figure with a faint suggestion of a tenth, but usually there are eleven. Two fine black lines extend along each side of the larva and between these is a wider yellow line and below these is a whitish band, below which is another fine black line. Short, light, yellowish-brown hairs are somewhat sparsely scattered over the body. These are much more numerous along the sides. On each joint, except the eleventh, there are two black, shining tubercles from which arise a few fine black hairs. The larvæ become mature about the first week in June. At this time they cease feeding and do not, as before, collect in groups, but wander singly over the tree, or sometimes away from it in search of shelter for the cocoon, which is soon to be made. They spin fine silken threads from the time they leave the egg and make inconspicuous webs, which are sometimes, though not usually, used as shelters, and if they drop from the branch on which they may be feeding, they hang by a thread. The final and chief use of this power to spin silk is seen in making cocoons.

*The chrysalis* is enclosed and protected by the oval, light yellow cocoon, which is made of the silk threads mentioned glued together into a parchment-like membranous cell. As soon as the cocoon is finished the larva inside moults for the last time and becomes a reddish-brown chrysalis or pupa, covered with a thick coat of yellowish hairs. After lying dormant for about three weeks, the chrysalis changes to a moth and the last stage in the life of the insect is reached. The moth (figure 1 b, female) is of a yellowish color. Across each front wing are two oblique, reddish-brown lines which are quite conspicuous, though not well shown in the figure. The body is grayish-brown. The males are only two-thirds as large as their mates. After pairing the males die, and as soon as the eggs are laid the females also die.

*Points of difference between the two species of tent-caterpillars.*—Though in many respects resembling each other, the two species of tent-caterpillar differ to such a degree as to be readily distinguished even from the outset. The egg clusters of each are placed upon young twigs, but their forms are quite different. The female moth of the forest tent-caterpillar produces an egg cluster which is of uniform size throughout and cut off squarely at each end, while in the common species the egg cluster is oval, because the ends are sloped or bevelled so that the diameter is not at all uniform from end to end.

The row of light spots along the back, which is a very characteristic mark of the former, is replaced in the latter by a light line. The red oblique lines upon the wings of the forest tent-caterpillar are of a light yellow color in the common species. Finally the very inconspicuous web of the forest tent-caterpillar is represented in the other species by the far too conspicuous and well known structure.

*Distribution.*—It has already been shown that during the past season the forest tent-caterpillar is widely distributed over this state, especially the eastern portion. It is also widely distributed over the United States. It is common and destructive in Virginia and still farther south. It extends west beyond the Mississippi and north to New Brunswick and Nova Scotia.

*Food.*—The species under consideration is a much more general feeder than is the common tent caterpillar, for while the latter is seldom found except upon the apple, cherry, or trees of that family, though by no means wholly limited to them, the forest tent-caterpillar feeds on all our common fruit trees, and on maples, oaks, walnuts, poplars, ash, etc. Its appetite seems to be variable for, while in some places it prefers the apple to any other tree, in others it chiefly attacks the sugar maple. Again these trees are largely neglected and the oak is sought, elsewhere it is the poplars that suffer most. In all cases there is loss of needed foliage and a corresponding injury done the tree.

*Remedies.*—It is very often true that the best remedy which can be used against injurious insects is prevention, and this is emphatically so in the present case. Prevention, however, is not always possible and remedies must be used. After the caterpillars have become established in a grove or orchard it is not easy to dislodge them, but something may be done to check their ravages. If, as may very likely occur, they gather in clusters on the trunk they may be crushed, and this should be done promptly for the opportunity may not come again. The clusters are most commonly formed in early morning or at dusk. A much less efficient method, but one which may be at the time the best which can be followed, is that of vigorously jarring the branches on which the worms are located. As they let themselves down by the thread they spin, they can be gathered in a pan of kerosene by sweeping a twig back and forth under the branch. Spraying the trees with paris green or other arsenite will sometimes be found an effectual and convenient remedy. On the whole, however, prevention by destruction of the egg clusters is better than any remedy. If the trees are carefully examined during the fall or winter, the egg clusters may readily be seen and can be removed by cutting off the twigs on which they have been formed. Every egg mass obtained lessens the number of caterpillars likely to appear in the spring by about 400. Unless an orchard is infested by migration from adjoining trees, this plan thoroughly carried out will prevent further damage. If there is either an orchard or grove of maples or oaks near by, it will be well to keep a sharp lookout during May and June for migration. Damage from this source may often be checked if not prevented by placing bands of well tarred paper, burlap, or any convenient cloth about the trunks of unattacked trees.

*Insect enemies.*—Fortunately the forest tent-caterpillar is attacked by several parasites which prevent its increase so effectually that it is seldom very destructive for many years in succession. There are also several beetles which devour the larvæ in considerable numbers.

## IV. THE OYSTER-SHELL BARK-LOUSE.

The apple scale, or oyster-shell bark-louse, *Mytilaspis pomorum*, B. is a common and well known insect, but as there appears to be no little error in the minds of some of my correspondents concerning its life history, a brief account may be useful. Before proceeding to a discussion of this species, it may not be out of place to give a few facts respecting the life history of scale insects in general.

There are no insects which pass through more singular transformations as they develop from the egg. In most of the species the mature females are fixed permanently to the spot upon which they have settled, having lost not only the locomotive organs, but often eyes, antennæ and other important parts as well. To compensate for this loss, however, the mouth parts, digestive and reproductive systems, as well as the mass of the body are especially developed. The young of both sexes are able to creep freely for a few days, but ere long, changes of a very different sort in the two sexes take place and the original characters are nearly all lost. The young female, after a brief period of activity, during which she moults several times, loses her legs, eyes and antennæ, grows much larger, and settles upon the bark and is soon covered with a scale which protects her and the eggs she is to produce. Her mouth has greatly enlarged and she thrusts her beak into the tree and sucks the sap on which she feeds. Where the insects are numerous they greatly weaken or even destroy the trees by the irritation and loss of sap which they cause.

The male larva usually does not become fixed, but develops more and more completely and becomes an active, winged insects with eyes and legs but no mouth. His sole function is to fertilize the females.

The oyster-shell bark-louse of the apple in most respects exhibits the above characters, but with a few important differences. It is easily distinguished from other species by its very elongated form, yet several specimens have been sent to the station by those who feared lest they might be the dreaded San Jose scale. Hence figures of both species are given herewith.*

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*I wish to call the attention of those interested in the subject to a most excellent article by Dr. L. O. Howard in the Year-book of the United States Department of Agriculture for 1894, on *Some Scale Insects of the Orchard.* I would recommend this article to all interested in the subject. I am glad to acknowledge my indebtedness to this paper for some of the facts here given and to Dr. Howard for kindly securing for the present article the illustrations which follow and which add so greatly to its value.

*Life history of Mytilaspis pomorum. The egg.*—The eggs are very minute, oval, yellowish bodies, varying in each scale in number. Howard says that there are "from 42 to 86." They hatch about the first of June, having been laid (according to Riley) the preceding August. The appearance [and location of the eggs is shown in figure 4 at a.

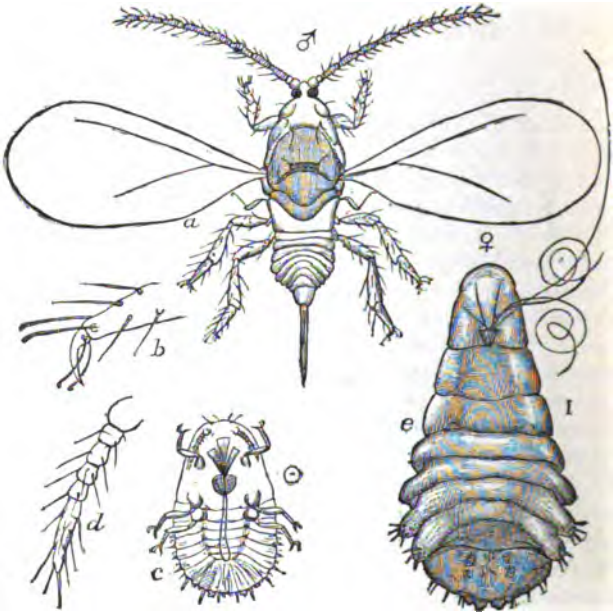

Fig. 3. ***Mytilaspis pomorum,*** **(a) adult male, (b) foot, (c) larva, (d) antenna of larva, (e) adult female. All very greatly enlarged (L. O. Howard).**

*Larva.*—As soon as the eggs hatch the young larvæ creep out from the protecting scale and wander about the tree. For three or four days they are quite active but are so very minute that they are rarely noticed. At this time they have the form shown in figure 3 c, the size being that of the dot inclosed in the circle at the right. They are soft bodied and if, at this time, they can be treated with kerosene emulsion or some similar insecticide, they are readily destroyed.

*Adult female.*—The life of the female larva does not differ materially in this species from that of most of the scale insects. After a few days of activity, she thrusts her beak into the bark and becomes immovably fixed. She soon loses legs, eyes, etc., grows rapidly for a short time and secretes the scale which extending back over the body furnishes a shelter for the eggs. Her form is shown in figure 3 e and by a comparison with c in the same figure some of the changes just noted may be better understood. The position of the insect in the scale is shown in figure 4, a and b.

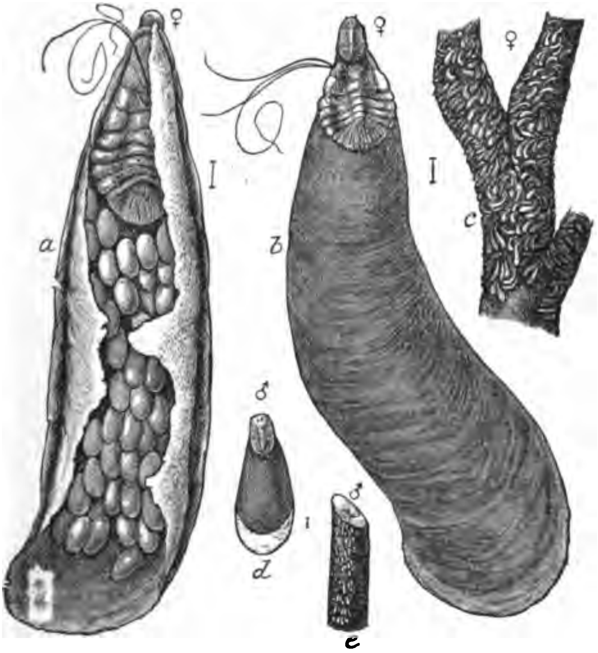

Fig. 4. *Mytilaspis pomorum*, (a) scale with female and eggs seen from below, (b) same from above, (c) female scales on the twig, (d) male scale from above, (e) male scales on the twig. All greatly enlarged. The lines at the right of the figures show natural size. (L. O. Howard.)

*Adult male.*—In many scale insects the male is active through life, but in this species he lives for a time under a small scale. At first active, he settles and secretes a scale of the form shown in figure 4 d. The difference between the male and female scales as found on the infested twigs is shown in figure 4, e and c. The male scales, however, are only temporarily occupied, for after a short time the insect emerges as a two-winged active creature shown in figure 3, a, about as unlike his mate as possible The color of the body of the male is purplish brown, while the wings are light. The female is yellowish. When fully grown the male is about $\frac{1}{60}$ inch long and the female, aside from the scale, somewhat longer. The male has no mouth and therefore does not eat, but lives only to fertilize the female, and this being accomplished dies.

*Remedies.*—Scale insects during most of their lives are so well protected by the scale that it is difficult to find any application that effectually destroys them. Obviously they can be most successfully treated during the few days when the larvæ are moving about free from their usual protection. This time is somewhat extended by the fact that, for several days after it is formed, the scale is thin and therefore less of a protection than later. When in any species this time can be ascertained, we have a valuable guide in the application of remedies. The oyster-shell scale is in this unprotected condition about the first week in June, earlier or later according to the season. If kerosene emulsion, 1 part in 10 of water, is applied to the branches infested the last week in May and again the second week in June, most of the insects will be reached and destroyed. If instead of spraying the trees the emulsion can be applied only on the branches with a brush it may be used in a stronger solution and will be more certain to destroy the insects. In any case it should be confined so far as possible to the branches, since when used as strong as recommended, it is very likely to injure the foliage. All nursery stock should be so treated before it is sent out.

While chiefly injurious to the apple, this scale is found upon some thirty species of trees and shrubs, hence all stock sent or received from nurseries should be carefully examined, for the pest will certainly spread from these to apple trees if there is any chance of its doing so.

*Insect enemies.*—There are several insects that devour this and other scales. The common lady bug is one of the most useful of these. There are several mites, as well as larger insects, that are helpful to some extent. At least one parasite has been found, a very tiny creature of the wasp family.

## V. THE SAN JOSE SCALE.

This much dreaded insect must for the first time be included in the list of injurious species found in Vermont. Fortunately it has thus far no foothold in the state. In the only case which I have known it was found on a few greenhouse plants brought from Ohio and was at once and thoroughly exterminated. It is not certain that a species which is so distinctly southern can live in our climate, but it is not safe to assume this, but rather to act very promptly if it is introduced. On this account I give a figure which may enable anyone to recognize it should it occur within our limits. As figure 5 well shows, the San Jose Scale is quite unlike any of the common species, and its circular form is often enough to identify it.

Although not at present fairly introduced, it is not too soon to warn those obtaining trees or plants from outside of the State to be on their guard, lest they introduce it. It is a somewhat general feeder and may live on a variety of plants. In the case mentioned above it was brought into the state on an ivy and an Otaheite orange. It should be fully understood that the pest can only reach Vermont as it is brought from without on living plants, and if all plants and trees imported into the state are carefully examined and, if infected, burned, we shall have no trouble. But it is to be feared that such inspection will not be given, and that somebody will be careless and admit the enemy. In any case it will be well if any scales of a circular form are found that they be sent at once to the station for examination.

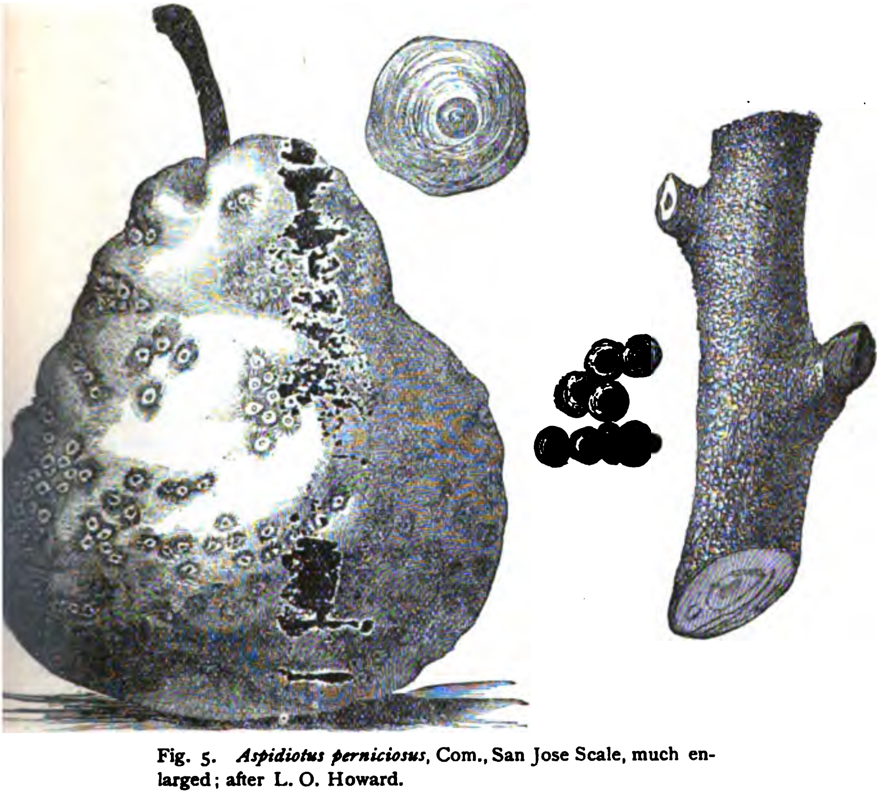

Fig. 5. *Aspidiotus perniciosus*, Com., San Jose Scale, much enlarged; after L. O. Howard.

*Laws concerning injurious insects.*—Laws requiring expert inspection of nursery stock and even of farms and orchards have been enacted in a few states and should be in all. Such laws would necessarily accomplish much in the way of prevention. Every nursery in the country should be inspected at least once in six months by a competent entomologist, and no stock on any account sent out without his certificate that it is free from insects.

The most comprehensive law thus far adopted is that of North Carolina, which is designed to check the increase of "noxious insects, fungus diseases and weeds which are affecting or may affect crops." A commission is appointed under this law to attend to the details of its thorough execution. The members of this commission prepare and publish lists of insects or other pests known to inhabit the state, they notify owners of orchards or any premises to remove such pests as may be harbored by them, they see that such premises are duly inspected, that nursery companies do not send out, and that transportation companies do not deliver infested stock. Suitable penalties are incurred by those infringing any of the provisions of the law. It may very probably be difficult to enforce completely such a law, but it seems to me that it must do much to accomplish the object for which it is established, and that there must be some kind of state control which shall prevent, or at least lessen, the carelessness and negligence of many farmers and gardeners seems evident. It is surely neither just nor reasonable to subject those farmers who, at the expense of money and labor, strive to keep their crops free from weeds and insects, to the injury which comes from the adjoining grounds of less energetic or less careful neighbors. One farmer in a town who allows weeds to go to seed and insects to breed without hindrance, undoes very much that his neighbors may do in exterminating these pests. Until everybody, voluntarily or by compulsion, shall use every effort to keep out injurious insects or plants, or to destroy them if they have established themselves, we can scarcely hope to be free from our annual vexations and losses from this source. If, however, some such law as that briefly outlined were enacted and enforced by competent authority our losses would surely be greatly lessened, and by an amount that would many times repay the cost of carrying out the most elaborately contrived system of legislation.

## VI. APPLE-TREE BORERS.

*The round-headed apple-tree borer*, *Saperda candida*, Fabr., has been reported as very troublesome in several localities during the past season. Its life history is briefly as follows: The eggs are laid in June or early July on the bark of apple trees usually within a foot or two of the surface of the ground, although in rare instances they may be deposited higher up on the trunk, or even on the branches. The eggs soon hatch into little white grubs with brown colored heads. These as soon as they are out of the egg bore into the bark, and then into the sap wood. During the second season they bore into the heart and may pass nearly through the stem, sometimes so weakening it as practically to cut the tree down. The larvæ have then attained their full size, being somewhat more than an inch long and change to chrysalids. During the third season they eat their way entirely out of the tree at a point several inches above that at which they entered. Having made an opening by which it can make its way into the outside world, the larva withdraws into the wood and remains quiescent for a short time, at the end of which it emerges as a beetle, of a long, narrow form, of gray or ash color with a broad white stripe running the length of the body on each side of the back.

*Remedies.*—Borers of all sorts are difficult insects to deal with since their depredations are so completely out of sight until the results begin to exhibit themselves that they may go on in their evil ways quite unnoticed and therefore unsuspected until much harm has been done. Moreover their habits protect them quite effectually from any application which can be used.

When the borer has entered a tree it may be cut out or destroyed with a pointed wire, but it cannot always be reached in any way. It is reported to us that success has been had in a limited way by pouring carbon bi-sulphide into the hole, immediately stopping the same with cotton wool. The fumes destroy the insect. The experiment upon which this statement is based was made on a single tree. While very effectual in this case, it will need confirmation by further trial. If verified this will prove a ready and simple means of combating the pest. The female may however be prevented from laying her eggs on the tree by covering it with strong alkaline washes, as strong lye, soft soap, etc. Kerosene emulsion would probably be serviceable though I have not tried it. Dr. Lintner recommends a wash made as follows: Into a gallon of common soft soap thinned with a pailful of hot soft water, a pound of crude carbolic acid is stirred. To this is added, after it has stood for a day or so, 30 gallons of cold water, making a barrel of liquid. This material is to be brushed over the trees from the surface of the ground up for at least two feet. The wash should be applied about the middle of June or a little earlier, and the trunk must be kept well covered with the wash during June and July. A very simple remedy is thus described in the *Country Gentleman*, March 20, 1890. After calling attention to the fact that the only way in which the borer can get into the tree is from the outside, the writer says: "Fold a newspaper three or four thicknesses, remove the earth at the foot of the tree two or three inches deep and wrap the paper from the bottom about the stem for at least a foot above the ground, crushing the paper in so as to fit all depressions where the insect might creep in. Tie all tightly with a string frail enough to break when the stem shall expand in midsummer or later, and bring the earth back and tramp it in at the foot of the tree. This simple plan I have followed for some six seasons and no borer has entered a tree thus guarded. The wrap should be put on early in May and need never be touched thereafter until the same time the ensuing spring when the protection is renewed." Certainly this remedy has the merits of simplicity, ease of application and economy, and if as efficient as asserted there can scarcely be anything better suggested.

*The flat-headed apple-tree borer, Chrysobothris femorata,* Fabr, is less often troublesome, but sometimes proves very injurious. This is a beetle of quite different form and appearance from the other species, and is only about half as large. The surface of the wings is grooved and furrowed and is of a greenish bronze, while the underside of the body is reddish bronze. It remains but one year in the tree, on which the eggs are laid in June or July. Very unfortunately it does not confine itself to the lower part of the trunk as does the other borer, but may lay its eggs anywhere, even on small branches, hence it is more difficult to find efficient remedies. It does not infest apple trees alone but may be found in several forest trees. I know of no remedies other than those mentioned above, and ordinarily they will be of service in checking the increase of the beetles, if they do not wholly prevent them. It should, however, be remembered that where the flat-headed borer is common, the alkaline washes must be applied much more extensively over the trees than is necessary if the other borer is alone present.

Woodpeckers, I believe, do much good by destroying borers. Titmice, creepers and other small birds may destroy the eggs which they find on the bark. It is wise to encourage the presence of these birds in our orchards for they are good friends of the fruit grower.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

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VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

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## BULLETIN No. 61

NOVEMBER, 1897

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## Hardy Apples for Cold Climates.

I. SUMMARY.—Page 19.
II. THE NORTHWARD PROGRESS OF APPLE GROWING.—Pages 21-26.
III. PRESENT STATUS OF APPLE CULTURE AS REGARDS HARDINESS OF TREES.—Pages 26-28.
IV. HARDY VARIETIES OF APPLES.—Pages 28-32.

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# BULLETIN NO. 61: HARDY APPLES FOR COLD CLIMATES.

By F. A. Waugh.

## I. SUMMARY.

II. The limit of successful apple culture has been moving steadily northward ever since the occupation of this country. Factors in this progress have been the planting of crab apples, dwarf apples, the introduction of the Russian varieties, and especially the selection of native hardy seedlings and the adoption of better orchard practice. (Pages 21-26.)

III. The present limit of the Baldwin and the Rhode Island Greening in Vermont has been investigated, and is shown by a map (Page 26). To grow a given variety further north it is recommended to choose a protected situation with a favorable exposure, and to top-graft upon the trunk (or branches) of a very hardy variety growing on its own roots. (Pages 26-28.)

IV. Varieties recommended for planting where hardiness is a principal consideration are: Yellow Transparent, Red Astrachan, Longfield, Oldenburg, Fameuse, McIntosh, Wealthy, Scott Winter, Pewaukee, Arctic, (Page 27.) Other varieties are described and discussed. (Pages 28-32.)

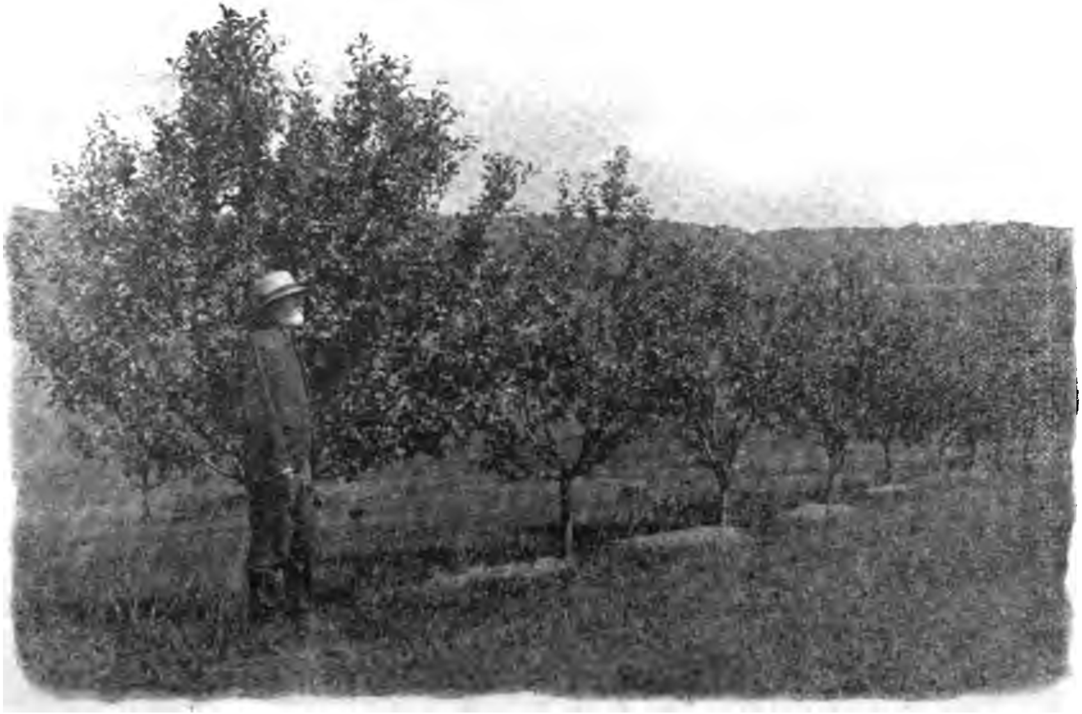

Fig. 1. Scott Winter. Bearing Trees in the Orchard of the Introducer, Dr. T. H. Hoskins, Derby, Vt.

## II. THE NORTHWARD PROGRESS OF APPLE GROWING.

The story of how the apple has, slowly but with steady sureness, made its way northward against the inclement climate of a strange land, keeping company with the undiscouraged pioneer and helping him always in his fight for a home, furnishing in the growth of the young orchard a sure testimonial of that home's successful establishment,—all this ought to be told by a novelist instead of by a matter-of-fact scientist. At all events it would be a theme for Thoreau or John Burroughs. Plain history or dry statistics are bound to leave the best things unsaid.

As American agriculture has moved onward and northward to appropriate new lands in severer climates the apple has been carried forward not easily but with a constant struggle against the unfavorable conditions. Immigration to Vermont, for example, was largely from the milder climates of Connecticut and Massachusetts. Many of the immigrants brought with them the favorite apples of their old homes, but frequently they failed because those varieties were not adapted to the Vermont climate. The old-time, well-known Baldwin was the subject of as many disappointments as any other variety, or perhaps as any other dozen, and even to the present day, after years of trial, it has been grown with difficulty and only indifferent success in but a few localities in the state. The history of the Baldwin is the history of hundreds of other sorts. It cannot seem strange that many people struggling with the difficulties of a wild country should become discouraged in fruit growing and should conclude that Vermont could never raise apples. Even after a century and a half of agricultural conquest there are yet people in the state who think just that. But they are mistaken. Apple growing has become a profitable industry in some parts of the state, and is entirely feasible, even on a commercial scale, in every town in Vermont. Those pioneers who tried to grow apples did not always fail. A few varieties were found to succeed; and the seeds dropped along roadsides and about buildings produced new trees, some of which were hardy enough for this climate and some fewer of which bore good fruit. Thus originated the Bethel, Tinmouth, Landon, Winter Pippin, Fay's Russet, and many other Vermont varieties.* The hardiest varieties of other neighborhoods were sought out and tested and the best retained. And when the farms reached a better state of cultivation, and when other rigorous circumstances were somewhat ameliorated, it was found easier than it had been to establish an orchard and to include in it first class varieties.

Some strange things have occurred in the development of apple growing in the cold counties of northern New England and the adjacent Canadian townships. One of the strangest of these was "the crab-apple craze." From forty to fifty years ago the fruit-tree agent, alive, active and ubiquitous in those days as in the present, sold crab-apple trees by the hundreds for orchard planting. The burden of his pleading seems to have been: "You can never grow the ordinary apples here. Crab-apples, however, are perfectly hardy and the fruit is almost as good as Baldwins and the like. I have a few fine trees to give away at fifty or seventy-five cents apiece; and as this is your only chance to grow apples you would better invest now." This story was very effective in some neighborhoods, and some large orchards of Siberian, Transcendent, Hyslop, Soulard and other crabs were planted.* Not all the good things promised by the tree agent were realized; and, for various reasons, the crab-apples did not give much abiding satisfaction. Many trees were rooted out; some were top-grafted; a few remain to this day.

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*This subject is discussed by Dr. T. H. Hoskins in American Gardening, Vol. 14. (1893), p. 23.

In other instances dwarf apple trees were quite extensively introduced by enterprising tree agents with the representation that they were the only stock qualified to succeed in the cold north.†

The introduction of the Russian apples, however, was the most notable effort to secure something hardier than the old-style varieties. This movement was of so much importance that it deserves special consideration. Unfortunately there has been so much misunderstanding and conflict of statement on this subject that the historical incidents, in spite of their comparatively recent occurrence, are difficult to discover, and still more difficult to present to the satisfaction of everybody. The following statements, however, are made in the faith that they cover the essential facts, and that they are true as far as they go.

One of the first men to import apple scions from Russia was A. G. Tuttle of Baraboo, Wis., who began this work about 1867. His work was done of his own private enterprise. He propagated or distributed several varieties. T. T. Lyon, speaking of Mr. Tuttle twenty-two years later, said, "he has now a considerable orchard exclusively of Russian varieties in full bearing." In 1870 the first general importation of Russian varieties was made by the United States Department of Agriculture from Dr. Regel of St. Petersburg. The trees were planted by William Saunders on the Department grounds at Washington, and scions from them were from time to time distributed to all parts of the country by Congressmen. This plan was of course bad in every way. Scions were sent to regions to which the varieties were not adapted in the remotest degree. Very few of them received an intelligent test even in those few sections where they might have been useful. Furthermore an almost marvelous confusion of nomenclature resulted which has not yet been half cleared up. In 1879 the Iowa Agricultural College made a similar importation. In 1882 J. L. Budd and the late Charles Gibb made their famous trip through central Europe, Russia, Poland, Ger-

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*See the article on "Orcharding" by Z. E. Jameson, in Rpt. Vt. St. Bd. Agr. 2 (1872 p. 93.

†Mr. Jameson, in the article already quoted, says: "About eight years ago dwarf apple trees were sold very extensively in several counties."

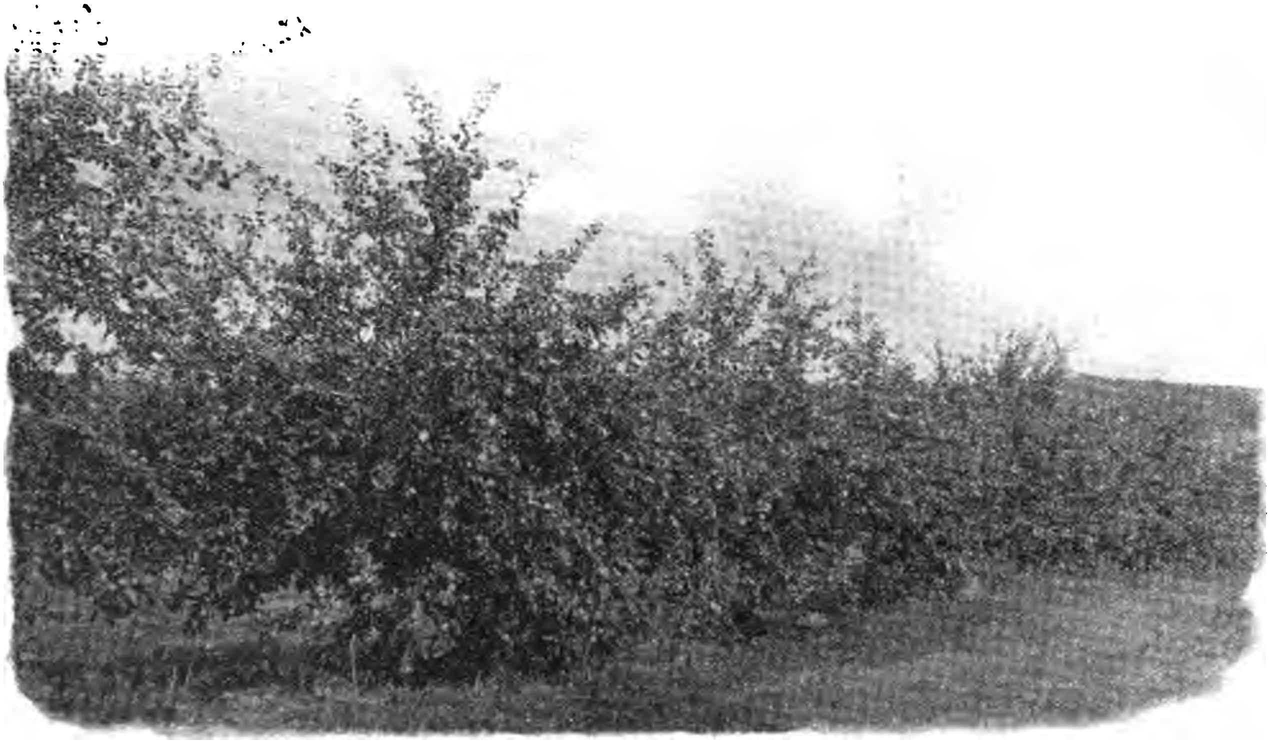

Fig. 2. Longfield. Bearing Trees in Dr. Hoskins' Derby Orchard. The drooping habit is characteristic of the variety.

many and Austria. Mr. Gibb died not many years after, leaving the distribution of the joint collection largely to Professor Budd. In the fifteen years since that time the multitudinous Russian varieties have been quite thoroughly tested in all parts of the United States and Canada where they promised to be of any value, and in many other places besides. Unfortunately all the distributions, either from carelessness or accident, seem to have been accompanied by new confusions of nomenclature, so that the labor of sifting useful from worthless varieties has been greatly retarded.

In referring to the introduction and testing of Russian apples in Vermont it would be inexcusable to omit mention of Dr. T. H. Hoskins, of Newport, whose energetic and intelligent efforts in the face of remarkable discouragements demonstrated the possibility of apple culture in the coldest towns of Vermont, and whose cogent writings diffused the knowledge which he gained to all parts of America.

This experiment station had a considerable number of Russian fruits growing on its grounds several years ago. When the field work was transferred in 1892 to the present farm, the young trees were sent out all over the state. This distribution numbered about 100 varieties, including all the leading Russians. A record of these trees has been kept and from time to time some of those to whom they were sent have reported their condition. Some of the trees have come into bearing; and the information thus furnished has been taken into account in the notes given on pages 29–32.

The Russian apples are now fairly well known; and yet it might not be an easy thing to say just what is and what is not a Russian apple. It is simple enough if we say that a Russian apple is an apple which comes from Russia. But these varieties, as a class, differing in some common characters from our ordinary varieties, do not all come from Russia; and not all the apples coming from Russia belong to this class. This may be more fully stated in the words of William A. Taylor, of the Division of Pomology, United States Department of Agriculture, taken from private correspondence:

> "As a pomological or botanical term the expression "Russian apple," should, in my opinion, be restricted to the somewhat distinct group of varieties which trace to the interior of Russia and which may be roughly characterized as follows:
>
> "Varieties usually dwarfish or but moderately strong growers, having leaves medium to large, often very large, thick, often with an extra layer of palisade cells; leaves and fruit resistant to apple scab but, in many varieties, leaves and young wood susceptible to blight; fruit variable in size from below medium to very large, usually symmetrical and often angular, almost invariably having a wrinkled or knotted and downy basin; color variable, ranging from greenish to clear whitish yellow, commonly more or less covered with brilliant blushes or stripes, rarely or never solid red, and in most varieties, particularly when grown in dry regions, covered with a pruinose bloom; flesh usually rather coarse in texture and of acid flavor, though in some varieties a mild sub-acid and in a few sweet; season of most varieties summer or fall, a few keeping well until spring when grown in the extreme north; chief use, cooking; trees resistant to extreme cold and commonly productive.

"The characters noted above are so strongly marked that they are transmitted to many of the seedlings grown in this country, such varieties as Wolf River, Patten Greening, McMahan, Dudley and Okabena being good examples. I have little doubt that a close study and comparison of the trees including leaves, wood, blossoms and fruit would disclose other distinctive characters.

"Many of the varieties that have reached this country from Russia are clearly not of the type referred to, but belong with the thin-leaved apples common to the humid regions of western Europe. So the fact that a variety came from Russia does not make it "Russian" in a pomological sense."

Considerable disappointment with the Russian apples has been felt in many quarters. This has been largely due to the fact that too much was expected of them: And this over-expectation in turn has been due to the optimistic and often unreasonable claims made for them through the injudicious, and unscience-like enthusiasm of some of the introducers. There has been a great deal of partisan discussion over the merits of the Russian apples, most of which has not advanced the interests of American pomology. But as the participants in this debate very soon saw that their interests are not advanced by such contentious arguments, we are now able to secure more sane and sober statements, and from them to make comparatively safer generalizations. The case for and against the Russian apples may be tentatively summarized as follows:

| FOR. | AGAINST. |
|---|---|
| They have given us several varieties of recognized value like Oldenburg and Yellow Transparent. | Very many of the varieties introduced are immensely worthless. |
| They promise to give us other useful varieties through gradual intercrossing with our common apples. | Most of them ripen too early and will not keep.[*] This is due to their introduction from a zone of shorter season to one of longer seasons. |
| They furnish hardy trunks on which more tender varieties may be grafted to advantage. | The fruit of many varieties drops badly before mature. |
| The trees are very hardy. | The fruit is usually coarse grained and of poor quality. |
| They are mostly free from disease (except blight.) | The skin is often very thin and tender, making the fruit liable to injury. |
| They usually bear early and abundantly. | Their nomenclature is so badly confused that no one can be sure of what he is handling. |
| The fruit is often large and finely colored. | The young growth is extremely subject to "fire blight." |
| Their introduction has encouraged many persons to grow apples in regions where they would not otherwise have attempted it. | |

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[*] "I doubt if more than two or three per cent of the apples from Russia, which are good commercial fruit, will be found to be good all-winter keepers." Dr. T. H. Hoskins, Am. Gar. 14, (1893), p. 23.

It should be said at once that all these statements are general, and that certain varieties can be named as exceptions to each particular article. This exhibit of the case, however, taken all together, is probably as fair and as accurate as actual knowledge permits.

The wildlings which grow along the fence rows and in old pastures, the "crabs," "natural fruit," "sauvages," "wild apples," the inspiration of Thoreau's classic essay, have been an unappreciated factor in the extension of apple growing toward the north. In early times almost all the orchards were of seedling trees, and a few such plantations even yet persist. Through the process of natural selection the cold winters removed all the weaklings. Only the hardiest remained, and from among these the most desirable ones have been propagated. Some of them have been named and have enjoyed a wide and honorable distribution. The seedling trees in other instances have been top-grafted to the best varieties and have thus furnished the basis for valuable orchards. A good seedling tree often makes the very best trunk upon which to work a good head of some less hardy variety like Baldwin or King of Tompkins county.

## III. PRESENT STATUS OF APPLE CULTURE AS REGARDS HARDINESS OF TREES.

In northern and eastern Vermont and in the mountain towns of higher altitude an apple tree is required which shall be at least above the average of hardiness. Northern Spy, Spitzenburg, King, Rhode Island Greening, Baldwin and Hubbardston Nonsuch can be grown with confidence in certain parts of the state, and in such places there is no need of seeking for specially hardy varieties. In order to ascertain more exactly what parts of the state stand in need of extra-hardy apples an extensive postal card inquiry was instituted. The results are summarized as well as possible in the accompanying map. North and east of the heavy line Baldwin and Rhode Island Greening seldom thrive for any number of years. South and west of the line they and other varieties of the same degree of hardiness, usually succeed. Of course there are exceptions to be made for favorable situations north of this mark and for unfavorable ones south of it; but in a general way this line indicates the limit of the successful culture of Baldwin and Greening.

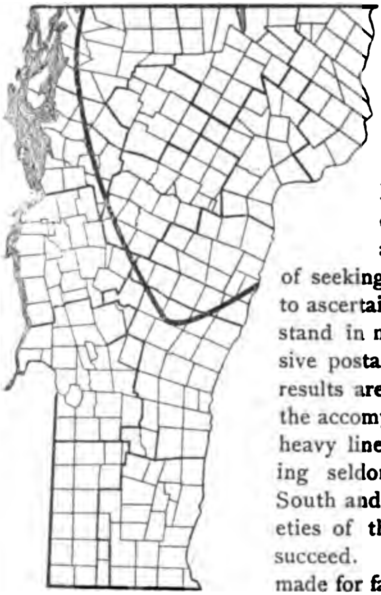

Fig. 3. Map of Vermont showing the General Limit of the Successful Culture of Baldwin and Rhode Island Greening Apples.

The orchard planter, however, is now able to select among a great many varieties hardier than Baldwin and Greening, some of which are entirely good. D. C. Hicks of North Clarendon, Vt., who has had many years of experience in Washington, Orange, Windsor, Windham and Rutland counties arranges a scale comprising eight degrees of hardiness, and names the following varieties as marking the several degrees:

1. Oldenburg, Pewaukee, North Star, Scott Winter.
2. Wealthy, Gideon, Wolf River, Yellow Transparent and Tetofsky.
3. Fameuse, Princess Louise, McIntosh and Shiawasse Beauty.
4. Blue Pearmain, Bethel, Summer Pearmain and Sweet Pearmain.
5. Northern Spy, Ben Davis, Edgar Redstreak, (Walbridge,) Gravenstein or Autumn Strawberry and Foundling.
6. Hubbardston Nonsuch, Sutton Beauty, Framingham Nonsuch and Canada Red.
7. Yellow Bellflower, Grimes Golden, Porter, Newtown Pippin, Holland Pippin and Fall Orange.
8. Baldwin, Canada Baldwin and King of Tompkins County.

Perhaps other observers would change the order of some varieties; but this arrangement, on the whole, will prove instructive. It shows a considerable range of hardiness above Baldwin and Greening, the two varieties taken as the basis of statistics for the accompanying map. In fact there are very few farms in the state on which varieties of the first five grades of hardiness may not be grown with reasonable certainty. Fameuse very seldom winter kills at Newport, and all the varieties of the first and second grades may be considered perfectly hardy in the coldest spots in the state. Dr. Hoskins has in Derby one of the highest, bleakest, most exposed and coldest locations in New England or Quebec; and when one sees his vigorous and thrifty orchard and the handsome crops it bears,—it being an entirely successful commercial orchard,—there can be little doubt that at least so far as hardiness is concerned, apples can be easily grown in any town in Vermont.

Any given variety, more or less sensitive to cold, can be grown from 50 to 150 miles north of its natural limit by reasonable precautions, such as the following:

1. Plant on land sloping south or south-east, and furnish good wind breaks to the north.
2. Secure thorough atmospheric drainage by choosing moderately high and sloping land.
3. Secure thorough underdrainage. If the subsoil is not porous enough to carry off all extra water it must be underdrained.
4. Buy trees on hardy stocks. In most grafted or budded trees the character of the stock is wholly unknown, but to grow a given variety at its northernmost limit, a perfectly hardy stock is required.
5. Graft the chosen variety in the tops of very hardy trees. In this way

many varieties can be grown in places where they will not succeed at all if budded or crown-grafted. Hardy seedlings, crab trees (Siberian, Transcendent, etc.) and the hardy Russian sorts like Hibernal, Oldenburg and Romna may be advantageously worked in this way. Probably the hardiest tree known is to be secured by growing Hibernal, or Romna (or others of equal hardiness and good tree form) *on their own roots*, and top-grafting with the variety desired for fruit. To secure a tree on its own roots the surest way is to graft a strong scion on a short root, planting the graft in the nursery deep in the soil. Roots will then usually be put out *from the scion*. An Hibernal tree is thus secured on Hibernal roots; and if the extraordinary hardiness of this variety is important for the tree top it must also be important for the root.

## IV. HARDY VARIETIES OF APPLES.

In the following pages some brief descriptive notes and field observations are given for those varieties of apples which seem to be hardiest and of most promise in other qualities for planting in the colder sections of the country. The list cannot be made complete. Some varieties are omitted which may seem to others to be of more importance than some which are included; but we have been as careful as possible in our omissions, and trust that the notes here given will be more instructive than misleading.

Several Russian apples are included in this list. In a few instances we have chosen to give notes of them not so much because of their greater value as on account of the demand for information concerning them.

There are some good varieties among the Russians. The best ten of these are named as follows by John Craig, Dominion horticulturist of Canada, who has had long and intimate experience with nearly all the varieties introduced. He recommends:

*Summer:*—Yellow Transparent, or Thaler, (Charlottenthaler), Pointed Pipka (Oldenburg type), Lievland Raspberry, Switzer, (late summer), Simbrisk No. 9.

*Fall:*—Golden White, Ostrekoff, Antonovka, Longfield, (or Good Peasant), Hibernal, (or Romna, or Cross).

*Winter:*—Arabka, Royal Table.

The trouble in buying stock of Russian varieties is that one can never be sure by the name given what he is getting. There are several distinct varieties passing under the name of Ostrekoff, several called Longfield, several Switzers, and so with others.

The varieties recommended by the American Pomological Society* for planting in northern New England and in Quebec are the following:

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*U. S. Dept. Agr., Div. Pom. Bul. 6, (Aug. 1897). This list is largely the work of T. T. Lyon of Michigan.

*Summer:*—Alexander,[*] Early Harvest, Haas, Pomme Gris, Red Astrachan[*], Sops of Wine.

*Fall:*—Fall Wine, Fameuse, Golding (Am. Golden Pippin), Pumpkin Sweet (Pound Sweet).

*Winter:*—Baldwin,[*] Canada Reinette, Gilpin, Peach (of Montreal), Pewaukee, Rhode Island Greening, Ribston, Scott Winter.

If we were to name the best ten hardy varieties for northern Vermont, including all classes, they would be the following:

*Summer:*—Yellow Transparent, Red Astrachan, Longfield, Oldenburg.

*Fall:*—Fameuse, McIntosh, Wealthy.

*Winter:*—Scott Winter, Pewaukee, Arctic.

Such a list is, of course, largely a matter of personal judgment. Anybody who knows what he is talking about is at liberty to have a different opinion.

The following pages give descriptive and field notes on some of the varieties in which planters of hardy apples will be most interested. It is not feasible to give a fuller list. The facilities of the station are such that information can be readily furnished concerning almost any other varieties. Persons wishing such information should not hesitate to address us.

*Alexander.*—A very large, showy Russian variety. Tree vigorous, spreading, perfectly hardy, productive; fruit very large, regularly formed, conical; skin greenish-yellow, faintly streaked with red on the shaded side, but orange, brilliantly streaked and marked with bright red in the sun; flesh yellowish-white, crisp, tender and juicy, with a rather pleasant flavor. Good. October to December. Tree subject to blight. Fruit does not sell well in years of plenty like the season of 1896. This year it was in demand and brought 25 cents a peck in the retail markets of the Province of Quebec.

*Anisette.*—As grown in Corinth, Vt., from stock furnished by this station, the fruit is small, irregular oblate, with a deep cavity and basin; skin yellow, thickly overlaid with crimson; flesh yellowish, pleasant sub-acid; quality fair to good. Loses flavor rapidly after maturing. Tree very hardy.

*Arabka.*—(Of Ellwanger & Barry.) This name has been applied to different apples. John Craig describes the best strain as follows: "Tree upright, vigorous, perfectly hardy, but suffering from blight; fruit large, flattish conic, deep green overlaid by purplish red; flesh greenish white, firm, coarse, sharp sub-acid, lacking in aroma and flavor; quality medium. December, March." (Rpt. Can. Exp. Farms, 1894, p. 129.)

*Arctic.*—Tree strong, vigorous grower, with straight, clean trunk and strongly set branches; foliage large and thrifty; fruit oblate, conical, medium to large size; cavity regular, medium; stem rather short and stout; basin irregular, medium; surface smooth, color yellow, washed heavily with red and splashed and striped with crimson, yellow dots; skin thick, tenacious and astringent; flesh yellow, tender juicy, core large and open, flavor sub-acid, quality good to very good. Late winter. This variety has been introduced extensively in Vermont, especially in Isle La Motte where it has fruited and gives promise of considerable usefulness. Reports from other sections indicate that it is comparatively very hardy.

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[*] Those marked with an asterisk are said to be specially desirable. This is manifestly misleading as regards northern Vermont. Baldwin and Rhode Island Greening are not hardy, and Early Harvest, Fall Wine and Sops of Wine are very doubtful.

*Ben Davis.*—Fruit medium to large. Form roundish, truncated conical, often sides unequal; color yellowish, almost entirely overspread, splashed and striped with two shades of red; flesh white, tender, moderately juicy, pleasant sub-acid. December to March. This variety which is a great favorite for market orchards in the south-west is being quite extensively planted all through Vermont. It is about as hardy as Northern Spy. It is a good bearer and sells well; but the quality is inferior.

*Canada Baldwin.*—This apple is said to have originated in Royville County, Quebec. Tree hardy, vigorous, thrifty grower, upright at first, gradually spreading with age and bearing; it begins to bear rather early, giving heavy and light crops on alternate years; it is a handsome fruit, of very good quality; considered one of the most valuable, long-keeping apples of its locality, both for market and family use. Fruit medium or below, oblate, skin quite white, thickly striped and splashed with rich red and crimson; flesh very white, fine, usually a little stained next the skin, and sometimes veined in the flesh, tender, juicy, refreshing, with a mild sub-acid, peculiar slight quince-like flavor; very good. January to April. Does best on heavy soil.

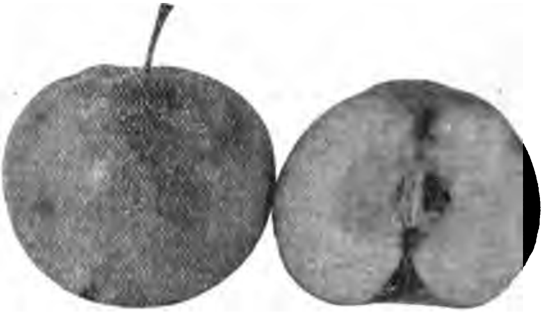

Fig. 4. Gideon.

*Edgar Redstreak.*—(Walbridge). Originated in Illinois. Tree hardy, vigorous, productive; fruit medium, oblate, whitish yellow, shaded with pale red in sun; flesh white, crisp, juicy, mild sub-acid. January to May. A good top grafting stock.

*Fameuse.*—(Snow.) This fine variety is too well known to need description. It is able to withstand almost the coldest winters and situations in this state, and is a favorite with many commercial growers in regions where absolute ironclads are not required. The Fameuse varies greatly, especially in color and prolificacy. Persons propagating it ought to take care to select scions from trees giving good crops of bright colored fruit almost annually.

*Gideon.*—Raised by Peter Gideon of Minnesota. Tree as hardy as Wealthy, which is of the same class; fruit large, roundish, angular, bright clear yellow overlaid with crimson in the sun; flesh firm, grainy, sprightly sub-acid, of fine quality. September, October. Is likely to be desirable for home use and early market. Fruit rots at core sometimes while still on the tree. See Fig. 4.

*Hibernal.*—This makes a fine strong tree much used for topworking in some sections. "One of the true ironclads that stands where Duchess fails." (Budd.) A late fall fruit inferior in most respects to Oldenburg.

*Jewett's Fine Red.*—(Nodhead). Of New Hampshire origin. Tree of moderate growth and productive, requires high culture to produce fair fruit; alternate bearer; fruit medium, round oblate, greenish white, striped, splashed and shaded with crimson; flesh tender, juicy, very pleasant, sprightly, almost sweet, good to very good, a favorite with some. November to February and later.

*Longfield.*—There are two or three varieties going under this name. The Longfield generally grown in Vermont and Quebec is the one introduced by Budd. The tree is spreading, drooping; fruit medium to small, nearly spherical, with shallow cavity and basin; color bright yellow covered in the sun by a warm crimson blush; skin thin and tender; flesh nearly white, fine grained, sub-acid; quality very good. October to December. A heavy annual bearer, must be thinned and well fertilized to give fruit of marketable size.

*McIntosh.*—(McIntosh Red). A fine variety for market or home use; of the Fameuse type, somewhat larger and, like the Fameuse, much subject to the scab fungus. It has the advantage, however, of being somewhat later. A desirable variety. Tree hardy.

*McMahan White.*—A good variety, about as hardy as Fameuse or hardier. Fruit large size and fine appearance, round and regular, waxy yellow with a pink blush; flesh white, crisp, juicy. November to January. Bears annually and moderately.

*Northern Spy.*—Of New York origin. The trees require high culture and open heads to let in the sun, otherwise the fruit is wanting in flavor and apt to be imperfect and knotty. The tree blooms late, often escaping vernal frosts and seems to require cross-pollination. This leading market variety can be grown in most parts of the state.

*Ontario.* — A Canadian variety said to be a cross between Northern Spy and Wagener, highly recommended by John Craig, Dominion horticulturist. Tree hardy and a good grower; rfuit large, ribbed oblate, dark green overlaid on one cheek with dark red; flesh firm, sub-acid; quality good, late winter.

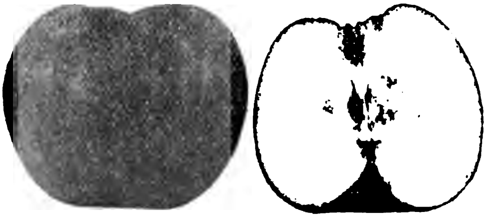

Fig. 5. Pointed Pipka.

*Pewaukee.*—Seedling of Oldenburg. Tree strong and vigorous, an annual bearer and one of the hardiest. Like Canada Baldwin this tree sunscalds badly. It does not succeed on light sandy soil.

*Pointed Pipka.*—(As known in the Province of Quebec.) This variety is of the Oldenburg type and is one of the best of the Russians. Tree a good grower and hardy and productive as Oldenburg; fruit medium size, flattened conical, greenish yellow heavily striped with deep red; flesh white, rather fine grained, quality moderately good. September. See Fig. 5.

*Red Astrachan.*—Said by Downing to have been imported to England from Sweden in 1816. Evidently of the Russian type. Perfectly hardy, an early and abundant bearer. Fruit rather large, smooth and fair; skin almost entirely covered with deep crimson; flesh quite white, crisp, juicy, with an agreeable acid flavor, quality good. July, August. Fruit ripens irregularly, necessitating two or three pickings.

*Romna.*—Oblate conic, of medium size, greenish yellow, washed with dull red and splashed with purplish red; flesh yellowish, moderately fine-grained, crisp, juicy; sub-acid, quality good, (W. A. Taylor.) For cooking only. Very hardy. This is of the Hibernal and Cross type. Not more than one variety of this type need be planted, as they much resemble each other. October. One of the better Russian varieties. See Fig. 6.

*Salome*.—This is being highly recommended by certain dealers. It seems to be hardy and desirable. Fruit medium size, conic, ribbed; skin green but tardily turning to pink; flesh yellowish white, firm, juicy, sub-acid, fair quality. Late winter. A fairly hardy tree; fruit not attractive.

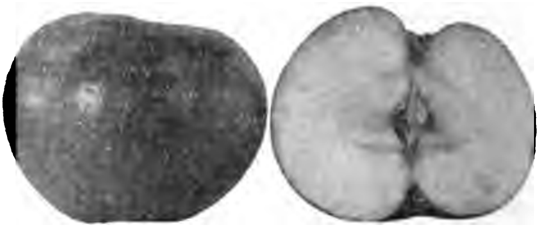

Fig. 6. Romna.

*Scott Winter*.—Introduced by Dr. T. H. Hoskins of Newport, Vt.; thoroughly tested in the coldest sections of this vicinity and found to be perfectly hardy. Valuable for its keeping qualities. Fruit small, flat, conic, irregular, smooth, light yellow, almost covered with bright red blotches and splashes and minute dots; basin deep, narrow, waved; eye small, closed; cavity small, narrow; flavor acid, quite tart but pleasant; quality good.December to spring. Is proving one of the most profitable winter apples inthe Province of Quebec. Bears annually.

*Tetofsky*. One of the best known of the Russians. An upright spreading grower, coming early into bearing and producing annually; very hardy. Fruit medium size, roundish, yellow, handsomely striped with red, flesh white and juicy, sprightly acid, fragrant and agreeable. Good. August. Not earlier nor more productive than Yellow Transparent and is not equal in quality to that variety.

*Wagener*.—Originated in Pen Yan, N. Y. Tree thrifty, upright, hardy, an early bearer; requires thinning to produce good flavored fruit; fruit medium or above, round oblate, yellow, mostly shaded with crimson. obscurely striped and sprinkled with light dots; flesh yellowish, very tender, juicy, excellent. Very good to best. November to February.

*Wealthy*.—A variety raised by Peter Gideon of Minnesota. The tree is hardy except in the most exposed locations; fruit medium, oblate; skin smooth, yellowish, shaded with deep rich red; flesh white, sometimes stained with red, tender, juicy, lively sub-acid; good. November to February.

*Winter St. Lawrence*.—Valued in parts of Canada, Fruit medium to large, round, slightly conical, skin yellow nearly covered with light and dark red splashes and broken stripes, flesh white, flaky, rather soft, juicy, brisk, sub-acid, melting, quality good. January and February. (John Craig.)

*Wolf River*.—A large handsome apple, supposed to be a seedling of Alexander, which it somewhat resembles. Tree very hardy, strong spreading grower, not an early bearer, but producing full crop alternate years; fruit large, oblate, slightly angular, skin whitish when mature, shaded with light and dark crimson; flesh white, rather coarse, juicy, pleasant, mild sub-acid. October, November.

*Yellow Transparent*.—One of the best know and most useful of the Russian varieties, perfectly hardy. Fruit medium, roundish oblate, slightly conical; skin clear white at first, becoming pale yellow; flesh white, tender, juicy, sprightly; good to very good. Ripening early. A first-class early market variety, but must be handled with care to avoid bruising the delicate skin.

UNIVERSITY OF VERMONT
AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 62

JANUARY, 1898

# Home-Grown Grapes in Vermont.

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    2. SPECIAL RECOMMENDATIONS.—Page 44.

MONTPELIER:
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Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN 62—HOME-GROWN GRAPES IN VERMONT.

By F. A. Waugh.

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## I. SUMMARY.

II. Good grapes for home use may be easily grown in Vermont. A warm site must be chosen. The common horizontal arm system furnishes the best method of pruning and trellising—(Pages 37-39). Vines should be covered in the fall (Page 38). Summer pruning is practicable within narrow limits. (Page 38.) Special attention must be paid to ripening the fruit. Early varieties must be grown, and the fruit left on the vine as long as possible. (Page 38.)

III. Several leading varieties of grapes are described and the results of tests given. The following are recommended:

Black.—Moore's Early, Worden.
Red.—Moyer, Brighton, Wyoming Red.
White.—Green Mountain, (Page 62).

Figure [illegible]. Worden Vine, Experiment Station Vineyard

## II. CULTURAL MEMORANDA.

The grape is one of the finest table fruits of temperate climates, but comparatively few residents of Vermont seem to have found it out. Like all perishable or semi-perishable fruits the grape is best when eaten fresh. It loses body, flavor and aroma in travelling a few thousand miles, lying some weeks in cold storage, standing a few days longer exposed on the vender's stand and being eaten in midwinter. And, besides, grapes have to be picked green to stand such usage, and they never ripen properly afterward. The grape is one of the most highly and delicately flavored of fruits when properly grown and *when thoroughly ripened;* and it is just these sugary, sprightly, vinous, refreshing qualities which make it so easy to produce second-class fruit.

All these things make it impossible to get the best grapes in the market, and render it imperative that they shall be home-grown. And all the foregoing considerations make it desirable that every farm should grow all the grapes needed for home use. Yet very few Vermont farms do have a home supply of grapes, and in many places where grape vines flourish the quality of the product is seriously lowered by inattention to important but very easily managed details. There are but few places in Vermont where commercial grape-growing will prove profitable; but attention may well be given to the production of small quantities of first-class dessert fruit for the home table and possibly for the local market.

A warm site should be chosen for grape vines. A southern exposure on rather sandy land may be preferred. Grapes need an abundance of sunshine in Vermont to ripen. They should not be planted in a neglected patch of sod but the ground about the roots should be kept cultivated. Bone fertilizers are said to be especially valuable for grapes.

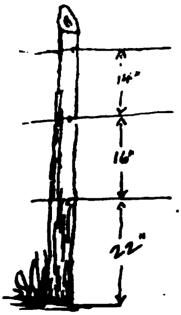

Fig. 2. Measurements for Trellis.

The most convenient trellis is usually made by three wires run horizontally at heights of about 22, 38 and 52 inches from the ground as shown in figure 2. When the vine is of bearing age one or two arms of one year old wood are carried in either direction from the plant along the lower wire as illustrated in figure 3. From each healthy bud of one year old wood a shoot will appear in the spring; and, as a rule, each of these shoots will bear near its base one to four branches of grapes. It is thus necessary to begin each spring with a fair number—20 to 40—strong one year old buds on each plant. At pruning time each year the vine must be cut back to its former dimensions. As this process removes from five-sixths to nine-tenths of all the wood of each vine it seems very harsh to the novice, until he is inclined to spare the pruning shears and let the vine run away with him. There are many interesting systems of vine pruning. One of the best is illustrated in the diagram. If the vine is bodily cut away at the points shown by the cross-lines AA, the canes BB may be brought down to the position now occupied by the arms CC, and the vine begins this year just where it began the last. The points in pruning to be emphasized with an inexperienced grape-grower are (1) to adopt a rational *system* of pruning and stick to it year after year, and (2) to prune enough. A grape vine on the back porch may be allowed to ramble to suit the owner's fancy, but most of the vines on trellises as seen about Vermont farms have ten or twenty times too much wood.

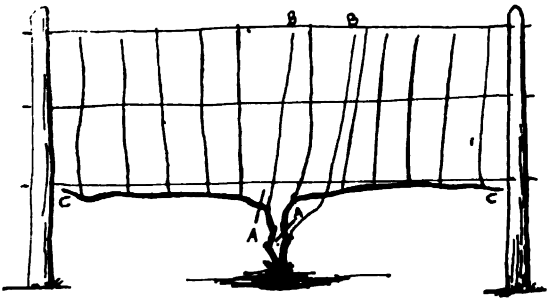

Fig. 3. Diagram of Horizontal Arm Method of Training.

It is well worth while in Vermont to cover most grape vines every winter. If they are properly pruned this is a very small job. The canes are loosened from the trellis, partially or finally pruned, laid upon the ground and held in place with small stones or a little soil. Evergreen boughs or clean hay or straw can then be thrown over them, or they can be covered entirely with soil. In the spring before the buds are started much, the canes are taken up, the stray finishing touches are given to the pruning, and the arms are tied in place on the trellis.

From time to time during the summer the young shoots need to be tied upward to the upper wires. If there is too much new growth and a superabundance of foliage it may be trimmed away with a sharp sickle or corn-knife late in summer so as to let the sun in upon the fruit. Such pruning must be done with caution, however, for if carried to excess it will diminish the crop and weaken the vine.

Special attention in this state must be paid to ripening the fruit. Very many persons fail at this point. Only the earliest varieties should be selected. Concord does not ripen oftener than once in three years on the shores of Lake Champlain, except in very favorable localities. Even then it must be left on the vines till after frost. The vines must have all the sunlight possible; and *the grapes must be left till ripe*. About one-half the grapes in this neighborhood seem to be picked green; most of the remaining half are picked unripe. A grape is not ripe as soon as it is colored, nor for a considerable time thereafter. It is best to leave it on the vine as long as possible. When the robins and the jays begin to take the fruit it is a fair time to pick. They are good judges of grapes.

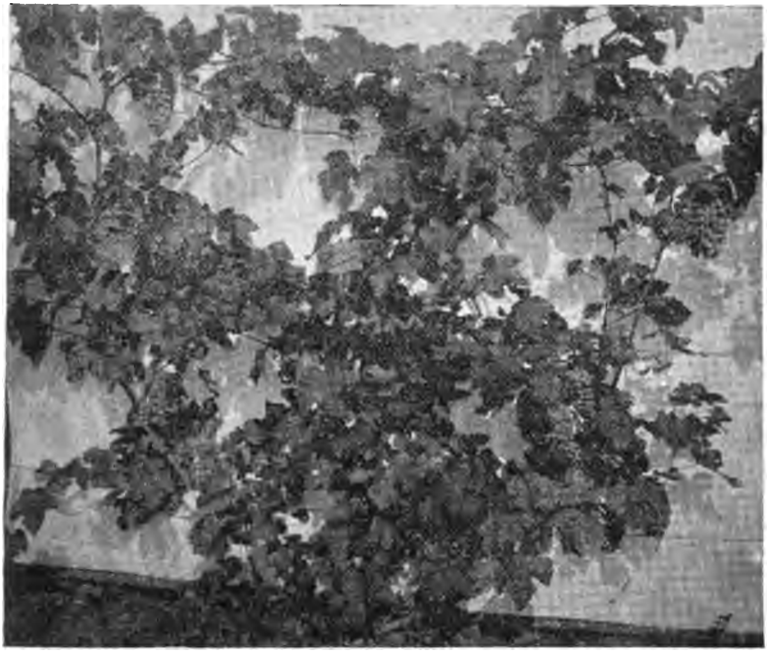

Fig. 4. Niagara Vine, Showing Horizontal Arm Training.

We have recently consulted several of the leading grape growers of Vermont on this subject and have taken many interesting notes. From many letters received we quote the following:

R. C. Goodale, Addison: Yes, our locality is good for market growing of grapes. The soil is right and those kinds mentioned (Delaware, Salem, Vergennes, etc.,) do not have to be covered, but should be to produce best.

Charles A. Hinsdill, North Bennington: I think grape growing for the home market would pay well if carried on in connection with other fruit growing, and the grapes retailed from the grower's wagons the same as his strawberries, etc. Fruit growers here do not know how to care for their vines to get early and high flavored fruit, and they all plant Concord—result, *failure!*

H. D. Alexander, Charlotte: Let me say grape growing for profit is dead as a door nail.

O. C. Waite, West Georgia. Unquestionably a large portion of our inhabitants, if they would give a little labor, care or skill, might have a bountiful supply of home-grown grapes during their season, while now hardly one family in fifty grows a single cluster of good grapes. * * * It seems to be an open question how much winter protection is necessary here. Some

Concords which have never been covered do not winterkill; while others, which have been covered formerly, have been killed from insufficient covering.

T. H. Hoskins, Newport: I have so far found only one grape, the Green Mountain, which ripens *perfectly* here. I feel sure that in time Vermont will grow her own grapes and perhaps supply other markets.

George H. Mass, Woodstock: Grapes for home use can be grown here and ripened if proper methods are used and due attention given to cultivating, especially in the Connecticut valley.

D. C. Hicks, North Clarendon: The soil and climatic conditions in this section of the Otter Creek valley are such that the growing of grapes for market could hardly be made profitable, but their culture for home use might be greatly increased by the planting of proper varieties in suitable soil and locations and with good after management. For such purpose I would recommend the following tested list: Champion, Vergennes, Worden, Moore's Early, Lady and Lindley; (untested as to fruitage) Green Mountain, Early Ohio, Alice and Campbell's Early.

C. W. Scarff, Burlington: By cutting back and pinching off surplus growth and properly covering in winter I get quite a bountiful yield of fine fruit, all of which finds use at home.

## III. VARIETY NOTES.

### 1. GENERAL LIST.

*Brighton. Red. Fairly strong grower, foliage good, crop good, bunches very large and fine, fruit of the very best quality, well ripened October first; will usually ripen, and is one of the best amateur's varieties.

*Brilliant. Red. Our vines are young, but bore a small crop of fair quality; ripens here about with Brighton, and is a promising variety.

Champion. Black. Very early, sure to ripen, hardy and a good grower, but so poor in quality as not to be worth growing.

*Concord. Black. The best known grape in America; hardy and prolific, quality good. It is not sure to ripen here and though almost always planted is very seldom seen in perfection. *Worden should be substituted for Concord everywhere in this state.*

Delaware. Red. This is a favorite variety and the standard of quality. It is, however, rather difficult to grow and not sure to ripen.

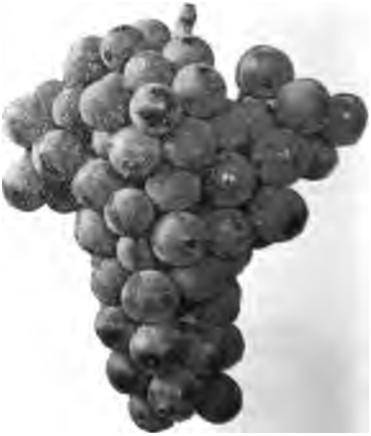

Fig. 5. Brighton.

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*Those varieties marked with an asterisk have been tested at this station.

*Empire State. White. Strong grower, gave a large crop of fine, compact bunches, ripens about with Niagara and cannot be depended on.

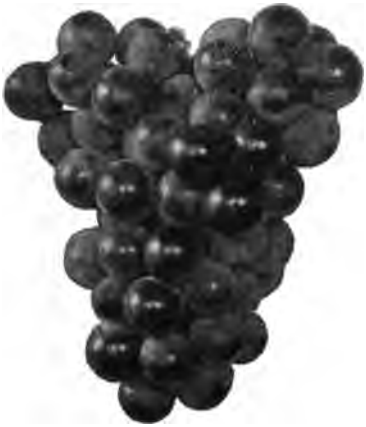

Fig. 6. Concord.

Green Mountain. White. We have not yet fruited this variety, but it has given abundant satisfaction in all parts of Vermont. Dr. Hoskins reports its full success at Newport. O. C. Waite of West Georgia says, "It really furnishes us as much satisfaction as all others put together." Of fair quality and very early.

Hartford (Hartford Prolific). Black. Strong grower, healthy, hardy, fairly prolific, very early and may always be depended on to ripen; its quality, however, is so poor that it is hardly worth growing.

*Ives. Black. A fairly good grower, but considerably affected with mildew this year; prolific. Ives colors early but does not ripen till several weeks later. Even then it is hardly eatable. Should be entirely discarded.

*Lady. White. Good, short-jointed canes, fairly good foliage, good crop, bunch straggling and berries small, ripening about with Concord. Not to be recommended for this section.

*Lady Washington. White. Good grower, moderately good foliage, fair crop, bunches rather straggling, seldom matures its fruit well and cannot be depended on.

*Merrimac. Black. Large, strong grower, good crop of large, well-filled bunches; berries large, sweet and meaty, of fine quality; ripens about with Concord and is well worth growing where the season is long enough.

*Moore's Diamond. White. Not a very good grower, foliage not quite clean and bright, fruit of fine appearance but not first quality. About the season of Concord or a trifle earlier, but difficult to ripen.

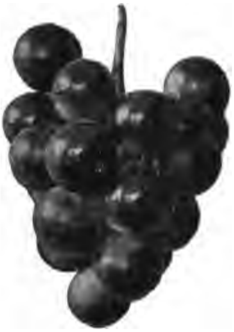

Fig. 7. Merrimac.

*Moore's Early. Black. Good grower, fairly good foliage, moderate or shy bearer, small bunches of large berries, quality good ; ripened this year September 10, and can be depended on to ripen every year. Charles A. Hinsdill, North Bennington, says: "I think Moore's Early will ripen more grapes under neglect than any other of the best home varieties." F. W. Blanchard, Ascutneyville, says: "Moore's Early is the grape for Vermont, first, last and always. It is early, fine flavored, sure, hardy and prolific. It has never failed me and my experience covers over ten years." H. D. Alexander, Charlotte, would discard this variety because it is such a shy bearer.

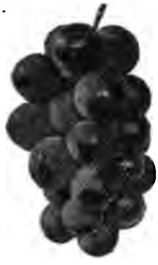

Fig. 8. Moyer.

*Moyer. Red. Not a very strong grower, but healthy with plenty of foliage, bears a moderate crop of small, well-filled bunches of excellent quality. This variety ripens early and is a very superior grape for home use. The bunches are small and the yield not large, but the quality is the best. This could be advantageously substituted for Delaware in most situations in Vermont.

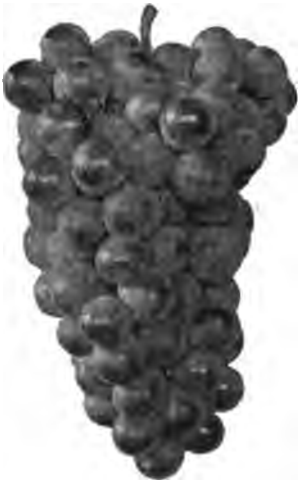

Fig. 9. Niagara.

*Niagara. White. Good grower, fine foliage, very prolific, fine, large bunches, of fine quality when ripe, but not sure to ripen here.

Salem. Red. A fine grower, with large bunches of large, sweet, meaty berries, vine much inclined to mildew, a trifle earlier than Concord, and a desirable variety *in some hands.*

*Ulster Prolific. Red. A very weak growing vine, foliage small and scant, fair crop of small bunches, fruit of good quality, ripening about October first.

*Vergennes. Red. Very strong grower, large, healthy foliage, good crop, bunches thin, berries large, of fine quality, keeping well, ripens too late for doubtful situations.

*Woodruff. Red. Very rampant grower, but will not ripen here.

*Worden. Black. A seedling of Concord and almost exactly like it except to be a stronger grower and ten days to two weeks earlier. *It should always be planted in preference to Concord in this latitude.*

*Wyoming Red. Red. A fine early, red variety, ripening with Moore's Early or before, strong grower, good foliage, prolific, sweet and juicy; well worth growing for home use.

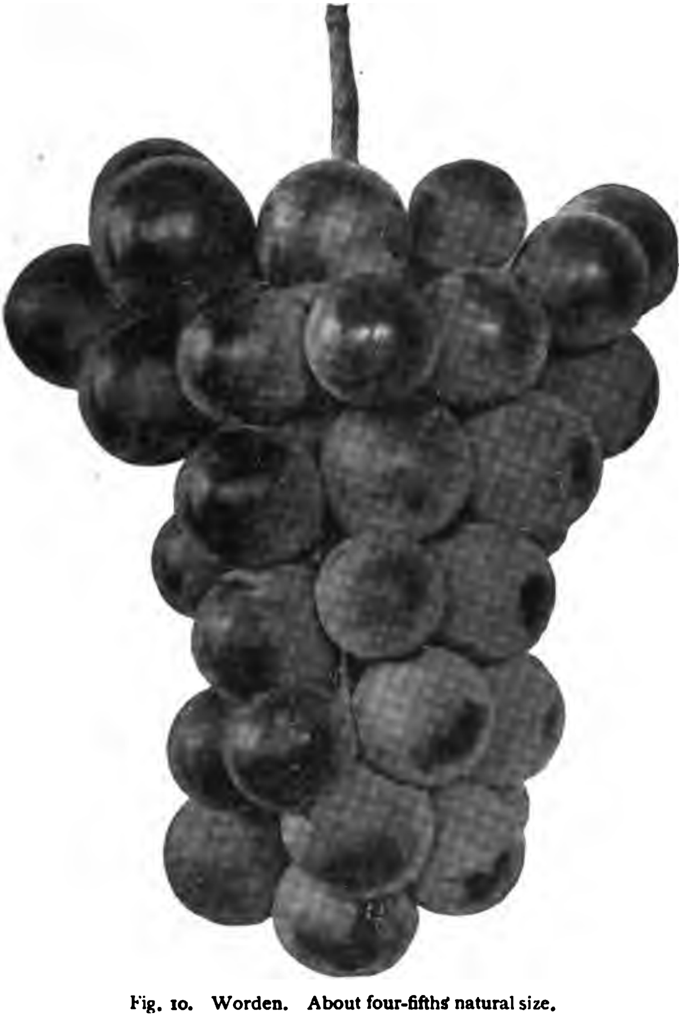

Fig. 10. Worden. About four-fifths natural size.

### 2. SPECIAL RECOMMENDATIONS.

If, now, we were asked to recommend a select list of grapes for home growing in Vermont, we should, on the basis of present experience. name the following:

*Black*,—Moore's Early, Worden.
*Red*,—Moyer, Brighton, Wyoming Red.
*White*,—Green Mountain.

Those which would be named as second choice would be:

*Black*,—Concord, Merrimac.
*Red*,—Brilliant, Delaware, Salem, Vergennes.
*White*,—Moore's Diamond, Niagara.

Of course the reader understands that such a list can never be made correct for everybody and for every location. Other growers with different tastes and amid different surroundings would choose a list varying more or less from this; but this selection is conservative, and may be relied on by prospective planters who have not the experience to choose for themselves.

In this connection it may not fall amiss to remind the reader once more that the experiment station has efficient means to secure reliable information concerning most named varieties of fruits, and that questions on these topics, as on all others connected with horticulture and agriculture, are at all times cheerfully answered. Many well-known varieties of grapes have been omitted from the foregoing list only for lack of space. Any questions about such other varieties or upon similar topics may be addressed to the

EXPERIMENT STATION,
Burlington, Vt.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

# VERMONT AGRICULTURAL
# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 63

MARCH, 1898

# Analyses of Commercial Fertilizers

I. Statement Regarding Analyses—Page 47
II. Schedule of Trade Values—Pages 47–53
III. Observance of the Fertilizer Law—Pages 53–54
IV. Licensed Fertilizers Sampled by Station—Pages 54–57
V. Analyses of Licensed Fertilizers—Pages 58–60

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1898.

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# BULLETIN NO. 63.

# ANALYSES OF COMMERCIAL FERTILIZERS.

BY J. L. HILLS, B. O. WHITE AND C. H. JONES.

## I. STATEMENT REGARDING ANALYSES.

The present bulletin contains analyses of 36 samples of leading brands of goods of each manufacturer licensed to sell in Vermont. Usually composite samples (mixtures of equal portions of several samples of the same brand taken at different points) have been analyzed, but in a few cases single samples only have been taken.

The choice of brands for immediate analysis and early publication is based largely upon the frequency with which they have been found in the search for samples during the four past as well as during the present season, this being regarded as an indication of comparatively extended use.

A second bulletin of analyses will be issued about April 20th, in which it is expected to include all the brands most commonly sold in the state. A third will be issued in May and will contain the analyses of the brands less widely used, together with a reprint of the analyses given in the March and April bulletins.

All samples are taken by agents of the experiment station from this year's shipments in the hands of local dealers, and represent therefore exactly what the purchaser is getting.

For detailed data regarding the meaning of the terms used in fertilizer analysis, the principles underlying the use of fertilizers, the elements of plant food, the sources of crude stock or raw materials used in manufacture, the commercial and agricultural values of fertilizers, the arguments in favor of and methods of home-mixing, the rational and economical selection, purchase and use of fertilizers, the reader is referred to bulletins 47 and 59 of this station which will be sent to any address upon application.

## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this state in 1898 is the one agreed upon by the experiment stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, after a careful study of prices ruling in the large markets of the Southern New England and the Middle States. For comparative purposes the schedule used last year is included in the tabulation.

## TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1897 AND 1898.

| | 1897<br>cts. per lb. | 1898<br>cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 13½ | 14 |
| " in nitrates | 14 | 13 |
| Organic nitrogen in dry and fine ground fish, blood and meat and in mixed fertilizers | 14 | 14 |
| " " in fine ground bone and tankage | 13½ | 13½ |
| " " in medium bone and tankage | 11 | 10 |
| " " in coarse " " | 8 | |
| Phosphoric acid soluble in water | 5½ | 4½ |
| " " " in ammonium citrate† | 5 | 4 |
| " " in fine ground bone and tankage | 5 | 4 |
| " " in medium* bone and tankage | 4 | 3½ |
| " " in coarse bone and tankage | 2½ | |
| " " insoluble (in ammonium citrate) in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate (or chlorids) | 5 | 5 |
| Potash as muriate | 4½ | 4¼ |

The above trade values are, as nearly as can be estimated, the average figures at which, in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, (Boston, New York, etc.,) in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st, plus about 20‡ per cent in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable average retail price in the large markets of standard raw materials such as sulphate of ammonia, nitrate of soda, muriate of potash, sulphate of potash, dried blood, plain superphosphate, (acid phosphate), azotin, dry ground fish, ammonite, cottonseed meal, bone, tankage and ground South Carolina or Florida rock.

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*The "medium" grade has been dropped for 1898, ground bone being graded as fine finer than 50 mesh) and coarse (coarser than 50 mesh.)

†Dissolved from 2 grams of the unground phosphate, previously extracted with pure water, by 100 c. c. of a neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes at 65 degrees C., with agitation once in five minutes; commonly called "reverted," or "back-gone" phosphoric acid.

‡Except in case of available phosphoric acid which has been purchased during the past year at many points, particularly in the Middle States, at very low prices. The "plus" in the case of this ingredient is far above 20 per cent.

## APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS.

The above trade values are applied to the valuation of superphosphates and mixed goods as follows:

The organic nitrogen is valued at 14 cents a pound, it being assumed that it is obtained from such materials as dried blood, high grade tankage, cottonseed meal, ground fish or nitrogenous substances of equally good quality.

Nitrogen in the form of nitrate of soda and sulphate of ammonia is valued at 13 and 14 cents a pound respectively.

Soluble, reverted and insoluble phosphoric acids in mixed fertilizers are valued at 4½, 4 and 2 cents a pound respectively.

Potash is valued at 4¼ cents a pound, the price of that ingredient in kainit and muriate, if there is sufficient chlorin in the fertilizer to unite with all the potash; if not, such as is not thus united is valued at 5 cents a pound, the price of that ingredient in high grade sulphate.

The "station valuation" of a fertilizer may be obtained by *multiplying the given per cent of each constituent (nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.*

## TRADE VALUE OF AVAILABLE PHOSPHORIC ACID.

The "trade values" for 1897 and 1898 vary but slightly except those of available phosphoric acid which rules a cent lower this year. Acid phosphate has been delivered at several points in the Middle States during the past year at three cents or less a pound of available phosphoric acid. It may be bought at freight centres to-day in lower New England and in many parts of the Middle States at figures as low or lower than those given in the schedule. The average wholesale quotation for available phosphoric acid for the past six months is 2.55 cents, and it is ruling during the present month at even lower figures. This average needs an addition of over 70 per cent to equal the schedule price. Dissolved boneblack, however, has sold at higher figures than has acid phosphate for several years. The wholesale quotations of these two forms of available phosphoric acid are now widely apart. At present prices dissolved boneblack is an expensive form of phosphoric acid. It is thought to be largely used by only one of the companies selling in Vermont.

It would appear from the above statement that in spite of lowered trade values there is still financial saving to be made by home mixing. The trade values for the various forms of nitrogen and potash are full high as compared with f. o. b. quotations to farmers in various parts of New Eng-

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*See footnote ‡ page 48.

Selling prices always exceed valuations, since the latter show only the seaboard values of unmixed ingredients and do not include necessary and legitimate charges accompanying the manufacture and sale of mixed goods, such as mixing, bagging, storage, freight, commissions to agents and dealers, selling on long credit, bad debts, interest on investment, depreciation of plant, profits, etc. If the selling price does not exceed the valuation more than 30 to 40 per cent it may not be too high, but in proportion as the excess increases beyond this point there is reason to question the economy of the purchase.

It is usually found that the low-priced brands are, commercially, the most costly. Last year's inspection developed the fact that:

(1) *One dollar spent for average low priced brands (below $29) bought 64 cents worth of plant food at retail seaboard prices; a dollar invested in average medium grade goods ($29 to $35), 69 cents worth; and a dollar paid out for average high class goods ($35 and upward), 72 cents worth.* A dollar bought 86 cents worth of plant food in one brand sold in the state last year, while it purchased but 50 cents worth in another brand. *One-fifth* of the entire number of brands furnished less than 60 cents worth of plant food to the dollar.

(2) *Thirty-two per cent of the total number of low priced goods contained plant food worth less than 60 cents for each dollar of cost,* while but *six per cent* of the total number of medium grade and *none* of the high grade brands contain as little *relative* value as this.

(3) *Seventy-two per cent of the total number of high class goods contain plant food worth more than 70 cents for each dollar of cost,* while but *twenty-nine* per cent of the total number of medium grade and but *sixteen* per cent of the total number of low priced brands contained as much *relative* value as this.

Low grade brands cost relatively high prices because the expenses of manufacture and sale are equally as great as and proportionately greater than those on high class goods. The companies as a rule prefer to sell the better goods, but there is a wide-spread popular demand for low priced goods, a desire "to get a lot for the money." General and local fertilizer agents report difficulty in selling the higher grades, which must usually prove more satisfactory because of the greater economy of purchase and the greater likelihood that first-class materials are used in manufacture.

## AGRICULTURAL VALUE OF COMMERCIAL FERTILIZERS.

It often occurs that consumers lay too much stress upon "valuation" and too little upon the analysis. The valuations stand in no direct or necessary relation to the comparative profits which may result from the use of the various brands. Their significance is almost purely commercial.

Buyers should remember that high class goods, giving relatively large values of plant food for the dollar invested, are usually rich in nitrogen, the most costly of the three ingredients. The dairy farmer need not buy this element in large quantities in his fertilizers. If he feeds concentrated feeds, if he is using absorbants and gypsum in the stable, if he prevents the manurial losses caused by fermentation and leaching, and if he gets his manure promptly upon the soil, he is usually supplying most of the needed nitrogen. Some of this element, however, may be needed in the more readily available forms as found in commercial fertilizers as a starter. Such a man usually needs to buy relatively little nitrogen, yet, notwithstanding, should get at least 65 or better, 70 cents worth of plant food for a dollar.

Among the points bearing upon economical and rational purchase, other than the relation of the selling price to the value of the plant food contained, and the advisability of "fertilizing by feeding," may be cited:

1. Previous experience obtained personally or by careful, observing, reliable neighbors with similar goods on the same or similar soil with the same crops.
2. Reputation of the firm offering the goods.
3. The advantages and disadvantages of home mixing as compared with the purchase of "mixed goods."
4. The character and amount of barn yard manure on hand.
5. The character, previous cropping and manuring of the soil.
6. The demands of the crop upon the plant food of the soil.
7. The analysis of the goods under consideration and its fitness for soil, crop, and as a supplement to home manurial supplies.
8. The forms in which the ingredients occur; nitrogen as nitrates, organic matter, etc., potash as muriate, as sulphate, etc.

## III. OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal.* Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however, that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not affected by the restrictions of the law.

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*H. J. Baker & Bro., New York, N. Y., have signified intention to take out a license.

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | Box 3404, Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | Box 3404, Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | P. O. Drawer 142. Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co., | State St., and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133–137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 92 State St., Boston, Mass. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass, |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 18 | Russia Cement Co | Gloucester, Mass. |

## IV. LICENSED FERTILIZERS SAMPLED BY STATION.

### Bowker Fertilizer Co., Boston, Mass.

**5921. Corn Phosphate**; from stocks of H. G. Barnes, Bethel; G. H. Manchester, South Royalton; K. T. Brown, Lunenburgh.

**5920. Stockbridge Manure for Potatoes**; from stocks of H. G. Barnes, Bethel; G. H. Manchester, South Royalton; W. C. Bugbee, Bridgewater; A. Whitcomb, Springfield.

**5919. Vermont Phosphate**; from stocks of G. H. Manchester, South Royalton; H. G. Barnes, Bethel; K. T. Brown, Lunenburgh.

### Bradley Fertilizer Co., Boston, Mass.

**5910. Corn Phosphate**; from stocks of E. A. Morse, Calais; G. D. Kidder, Plainfield; Dutton and Richmond, Northfield; D. Spooner, Randolph; S. Davis, Danville.

**5912. Eclipse Phosphate**; from stocks of E. A. Morse, Calais; G. D. Kidder, Plainfield; G. H. Tupper, Bethel; S. Davis, Danville.

**5911. Potato Fertilizer**; from stocks of E. A. Morse, Calais; G. D. Kidder, Plainfield; Dutton and Richmond, Northfield; D. Spooner, Randolph; S. Davis, Danville.

**5909. XL Superphosphate of Lime**; from stocks of E. A. Morse, Calais; G. D. Kidder, Plainfield; D. Spooner, Randolph; G. H. Tupper, Bethel; S. Davis, Danville.

### Clark's Cove Fertilizer Co., Boston, Mass.

**5937. Bay State Fertilizer, G. G.**; from stocks of J. H. Silsby, Lunenburgh; J. H. Hewitt, South Royalton.

### Cleveland Dryer Co., Boston, Mass.

**5913. Corn and Grain Phosphate**; from stocks of S. C. Wheeler, Waterbury; D. Spooner, Randolph; B. M. Ellinwood, Cambridge.

**5914. Potato Phosphate**; from stocks of S. C. Wheeler, Waterbury; D. Spooner, Randolph; M. A. Nelson, Montpelier; B. M. Ellinwood, Cambridge.

### E. Frank Coe Co., New York, N. Y.

**5917. Columbian Corn Fertilizer**; from stocks of Miles, McMahon & Co., Stowe; Kent and Vinton, Montpelier; F. T. Russell, East Hardwick; A. E. Tolman, Greensboro.

**5918. Columbian Potato Fertilizer**; from stocks of Miles, McMahon & Co., Stowe; Kent and Vinton, Montpelier; F. T. Russell, East Hardwick; A. E. Tolman, Greensboro; E. S. Stratton & Son, Craftsbury.

### Crocker Fertilizer & Chemical Co., Buffalo, N. Y.

**5927. Ammoniated Corn Phosphate**; from stocks of E. A. Dutton, East Craftsbury; Lang Bros., Barnet; E. G. Lord, Pompanoosuc; H. L. Rice, Fairlee; O. P. Chamberlin, Bridgewater; Isaiah Benson, West Woodstock; John Eaton, Springfield.

**5926. New Rival Ammoniated Bone Superphosphate**; from stocks of Fred Fuller, Montpelier; Isaiah Benson, West Woodstock; H. L. Rice, Fairlee; S. P. Curtis & Son, Rutland; Lang Bros., Barnet.

**5298. Potato, Hop and Tobacco Phosphate**; from stocks of H. L. Rice, Fairlee; E. A. Dutton, East Craftsbury; Lang Bros., Barnet; Fred Fuller, Montpelier; Isaiah Benson, West Woodstock; O. P. Chamberlin, Bridgewater; John Eaton, Springfield.

### Cumberland Bone Phosphate Co., Boston, Mass.

**5916. Potato Fertilizer**; from stocks of J. B. Hyde, Moscow; W. L. Pierce, East Calais; W. H. Nye, Johnson.

**5915. Superphosphate**; from stocks of J. B. Hyde, Moscow; W. L. Pierce, East Calais; W. H. Nye, Johnson.

### Great Eastern Fertilizer Co., Rutland, Vt.

**5936. General Fertilizer**; from stocks of George Dow, Cabot; L. W. Holt, East Barnard; E. L. Winslow, Prosper; B. M. Weld, New Haven; L. W. Fisher, East St. Johnsbury; C. B. Whitney, Barnet.

**5935. Grass and Oats Phosphate**; from stocks of L. C. Sturtevant, Weybridge; E. L. Winslow, Prosper; L. W. Holt, East Barnard; L. W. Fisher, East St. Johnsbury; C. B. Whitney, Barnet.

**5934. Potato Manure**; from stocks of George Dow, Cabot; George Coffran, East Calais; L. W. Holt, East Barnard; E. L. Winslow, Prosper.

### Lister's Agricultural Chemical Works, Newark, N. J,

**5904. Special Potato Fertilizer**; from stocks of H. V. Shaw, Stowe; C. E. Jackson, Montpelier; C. L. Hodges, Randolph Center; George A. Chase, East St. Johnsbury.

**5903. Success Fertilizer**; from stocks of John Poor, Craftsbury; H. V. Shaw, Stowe; C. E. Jackson, Montpelier; C. L. Hodges, Randolph Center.

### Lowell Fertilizer Co , Boston, Mass.

**5908. Swift's Bone Fertilizer for Corn and Grain**; from stocks of E. H. Sherwin, Johnson; H. A. Austin, Wolcott; J. A. Gallagher, Hardwick; Ira Bemis, Marshfield.

**5931. Swift's Potato Phosphate**; from stocks of J. A. Gallagher, Hardwick; B. S. Hooker, Bradford; Ira Bemis, Marshfield.

### Pacific Guano Co., Boston, Mass.

**5925. Nobsque Guano**; from stocks of Richard Pixley, Norwich; O. L. Miner, Brattleboro; H. S. Tabor, Montpelier.

**5924. Soluble Pacific Guano**; from stocks of H. S. Tabor, Montpelier; O. L. Miner, Brattleboro; F. W. Partch, New Haven; Richard Pixley, Norwich; C. W. Coffran, Lyndonville.

### Quinnipiac Co , Boston, Mass.

**5922. Corn Manure**; from stocks of H. Ballard, East Poultney; Mellen & Proctor, Brattleboro; N. W. Bates, Essex Center.

**5923. Potato Phosphate**; from stocks of H. Ballard, East Poultney; Mellen & Proctor, Brattleboro; N. W. Bates, Essex Center.

### Read Fertilizer Co., New York, N. Y.

**5932. Practical Potato Special**; from stocks of W. N. Flynn, Underhill; C. W. Comstock, Barton; A. M. Temple, Newport.

### Russia Cement Co., Gloucester, Mass.

**5933. Essex XXX Fish and Potash**; from stocks of J. C. Wilson, Craftsbury; C. A. Hutchinson, Barnet; N. W. Carter, Wells River.

### Standard Fertilizer Co., Boston, Mass.

**5620. Fertilizer**; from stock of C. W. Atherton, Waterbury.

### Henry F. Tucker Co., Boston, Mass.

**5929. Imperial Bone Superphosphate for Corn**; from stocks of M. A. Nelson, Montpelier; G. D. Kidder, Plainfield; E. J. Foster, Sudbury.

**5930. Imperial Bone Superphosphate for Potatoes**; from stocks of G. D. Kidder, Plainfield; E. J. Foster, Sudbury; M. A. Nelson, Montpelier.

### Williams and Clark Fertilizer Co., Boston, Mass.

**5907. Americus Corn Phosphate**; from stocks of A. W. Bailey, Montpelier; A. G. Dutton, East Calais; C. S. Kimball, Northfield; E. Prior, Cambridge; J. & A. D. Long, Stowe; Urie & Sawyer, Craftsbury; J. McDowell, Greensboro.

**5905. Americus Potato Manure**; from stocks of J. & A. D. Long, Stowe; Urie & Sawyer, Craftsbury; A. G. Dutton, East Calais; C. S. Kimball, Northfield; A. W. Bailey, Montpelier.

**5906. Royal Bone Phosphate**; from stocks of A. W. Bailey, Montpelier; A. G. Dutton, East Calais; C. S. Kimball, Northfield; Urie & Sawyer, Craftsbury.

### EXPLANATION OF TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers upon the next three pages show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 48 of this bulletin, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicised* type gives *guarantees*, the **black-face** type gives the **most important figures found by analysis.**

## V. ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton.† | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton.† | Found. | Guaranteed. | Valuation of Potash in One Ton.† | |
| 5921 | Bowker's Corn Phosphate | 0.42 | ...... | 1.51 | **1.93** | *1.5* | $5.32 | 5.25 | 3.22 | 2.07 | **10.54** | *11.* | **8.47** | *9.* | $ 8.13 | **2.34** | *2.* | $1.99 | 5921 |
| 5920 | Bowker's Stockbridge Potato Manure | 1.21 | ...... | 2.27 | **3.48** | *3.2* | 9.51 | 5.15 | 2.44 | 1.66 | **9.25** | *7.* | **7.59** | *5.* | 7.25 | **10.26** | *10.* | 8.72 | 5920 |
| 5919 | Bowker's Vermont Phosphate | 0.96 | ...... | 1.60 | **2.56** | *1.75* | 6.98 | 6.63 | 2.78 | 1.28 | **10.69** | *10.* | **9.41** | *8.* | 8.70 | **4.58** | *3.* | 3.89 | 5919 |
| 5910 | Bradley's Corn Phosphate | ...... | ...... | 2.07 | **2.07** | *2.06* | 5.80 | 5.67 | 4.09 | 2.82 | **12.58** | *10.* | **9.76** | *9.* | 9.50 | **1.74** | *1.5* | 1.48 | 5910 |
| 5912 | Bradley's Eclipse Phosphate | ...... | ...... | 1.67 | **1.67** | *1.* | 4.68 | 5.30 | 5.18 | 2.60 | **13.08** | *12.* | **10.48** | *10.* | 9.95 | **1.78** | *1.5* | 1.51 | 5912 |
| 5911 | Bradley's Potato Fertilizer | ...... | ...... | 2.18 | **2.18** | *2.06* | 6.10 | 5.99 | 3.08 | 2.49 | **11.56** | *11.* | **9.07** | *9.* | 8.85 | **3.49** | *3.25* | 2.97 | 5911 |
| 5909 | Bradley's XL Superphosphate | ...... | ...... | 2.52 | **2.52** | *2.5* | 7.06 | 6.72 | 3.78 | 1.85 | **12.35** | *11.* | **10.50** | *9.* | 9.81 | **2.08** | *2.* | 1.77 | 5909 |
| 5937 | Clark's Cove Bay State Fert. G. G. | ...... | ...... | 2.15 | **2.15** | *1.85* | 6.02 | 5.34 | 3.87 | 2.51 | **11.72** | *10.* | **9.21** | *8.5* | 8.91 | **2.37** | *2.* | 2.01 | 5937 |
| 5913 | Cleveland Corn and Grain Phosphate | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.41 | 3.97 | 3.01 | **12.39** | *10.5* | **9.38** | *9.5* | 9.25 | **1.60** | *1.5* | 1.36 | 5913 |
| 5914 | Cleveland Potato Phosphate | ...... | ...... | 2.11 | **2.11** | *2.06* | 5.91 | 5.63 | 3.24 | 3.02 | **11.89** | *10.* | **8.87** | *8.* | 8.87 | **3.30** | *3.* | 2.81 | 5914 |
| *5917 | Coe's Columbian Corn Fertilizer | ...... | ...... | 1.51 | **1.51** | *1.23* | 4.23 | 7.46 | 3.37 | 2.37 | **13.20** | *11.* | **10.83** | *9.* | 10.36 | **2.06** | *1.85* | 2.06 | 5917 |
| *5918 | Coe's Columbian Potato Fertilizer | ...... | ...... | 1.53 | **1.53** | *1.23* | 4.28 | 7.48 | 3.16 | 2.42 | **13.06** | *11.* | **10.64** | *9.* | 10.23 | **1.98** | *1.85* | 1.98 | 5918 |

*** Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.**

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to **that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52.**

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton.† | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton.† | Found. | Guaranteed. | Valuation of Potash in One Ton.† | |
| 5927 | Crocker's Ammo. Corn Phosphate... | ...... | ...... | 2.09 | **2.09** | *2.* | $5.85 | 6.54 | 3.59 | 1.19 | **11.32** | *11.* | **10.13** | *10.* | $9.23 | **1.87** | *1.6* | $1.59 | 5927 |
| 5926 | Crocker's New Rival Ammo. Bone... | ...... | ...... | 1.32 | **1.32** | *1.23* | 3.70 | 6.02 | 4.45 | 1.56 | **12.03** | *11.* | **10.47** | *10.* | 9.60 | **1.80** | *1.6* | 1.53 | 5926 |
| 5928 | Crocker's Potato, Hop and Tobacco.. | ...... | ...... | 2.28 | **2.28** | *2.* | 6.38 | 6.89 | 3.11 | 1.23 | **11.23** | *11.* | **10.00** | *10.* | 9.18 | **3.32** | *3.25* | 2.82 | 5928 |
| 5916 | Cumberland Potato Fertilizer.......... | 0.30 | ...... | 1.77 | **2.07** | *2.06* | 5.74 | 4.62 | 4.52 | 3.02 | **12.16** | *11.* | **9.14** | *9.* | 8.98 | **2.98** | *3.* | 2.53 | 5916 |
| 5915 | Cumberland Superphosphate........... | 0.34 | ...... | 1.92 | **2.26** | *2.06* | 6.26 | 6.02 | 4.08 | 2.02 | **12.12** | *10.* | **10.10** | *8.* | 9.49 | **2.22** | *2.* | 1.89 | 5915 |
| 5936 | Great Eastern General Fertilizer...... | ...... | ...... | 1.05 | **1.05** | *0.82* | 2.94 | 6.36 | 2.36 | 1.01 | **9.73** | *9.* | **8.72** | *8.* | 8.02 | **4.37** | *4.* | 3.71 | 5936 |
| 5935 | Great Eastern Grass and Oat Fert.... | ...... | ...... | ...... | ...... | ...... | ...... | 7.14 | 3.64 | 1.31 | **12.09** | *12.* | **10.78** | *11.* | 9.86 | **2.10** | *2.* | 1.78 | 5935 |
| 5934 | Great Eastern Potato Manure.......... | ...... | ...... | 2.38 | **2.38** | *2.06* | 6.66 | 6.03 | 2.40 | 2.00 | **10.43** | *9.* | **8.43** | *8.* | 8.15 | **4.28** | *4.* | 3.64 | 5934 |
| ‡5904 | Lister's Special Potato Fertilizer...... | ...... | 0.19 | 1.60 | **1.79** | *1.65* | 5.01 | 6.25 | 2.61 | 2.01 | **10.87** | *9.* | **8.86** | *8.* | 8.52 | **3.30** | *3.* | 2.90 | 5904 |
| 5903 | Lister's Success Fertilizer.............. | ...... | 0.19 | 1.26 | **1.45** | *1.24* | 4.06 | 7.25 | 2.74 | 1.89 | **11.88** | *11.5* | **9.99** | *9.5* | 9.47 | **2.36** | *2.* | 2.01 | 5903 |
| 5908 | Lowell Swift's Bone Fertilizer......... | ...... | ...... | 1.79 | **1.79** | *1.65* | 5.01 | 5.08 | 3.23 | 1.71 | **10.02** | *9.* | **8.31** | *8.* | 7.84 | **3.33** | *3.* | 2.83 | 5908 |
| *5931 | Lowell Swift's Potato Phosphate .... | ...... | 0.19 | 2.67 | **2.86** | *2.47* | 8.01 | 4.85 | 3.80 | 1.43 | **10.08** | *9.* | **8.65** | *8.* | 7.98 | **6.08** | *6.* | 5.94 | 5931 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52.

‡ Potash partly as sulphate.

## ANALYSES OF LICENSED FERTILIZERS.

| Station Number. | BRAND. | NITROGEN. | | | | | | PHOSPHORIC ACID. | | | | | | | | POTASH. | | | Station Number. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total. | | Available. | | | | | | |
| | | From Nitrates. | From Ammonia Salts. | From Organic Matter. | Total Found. | Total Guaranteed. | Valuation of Nitrogen in One Ton.† | Soluble. | Reverted. | Insoluble. | Found. | Guaranteed. | Found. | Guaranteed. | Valuation of Phosphoric Acid in One Ton.† | Found. | Guaranteed. | Valuation of Potash in One Ton.† | |
| 5925 | P. G. Co.'s Nobsque Guano............ | ...... | ...... | 1.16 | **1.16** | *1.15* | $3.25 | 5.70 | 2.81 | 1.82 | **10.33** | *9.* | **8.51** | *8.* | $ 8.11 | **2.11** | *2.* | $1.79 | 5925 |
| 5924 | P. G. Co.'s Soluble Pacific Guano..... | ...... | ...... | 2.13 | **2.13** | *2.25* | 5.93 | 4.87 | 4.53 | 2.21 | **11.61** | *10.5* | **9.40** | *8.5* | 8.89 | **2.21** | *2.* | 1.88 | 5924 |
| 5922 | Quinnipiac Corn Manure........... ..... | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.86 | 3.93 | 2.14 | **11.93** | *10.* | **9.79** | *9.* | 9.27 | **1.63** | *1.5* | 1.39 | 5922 |
| 5923 | Quinnipiac Potato Phosphate......... | ...... | ...... | 2.23 | **2.23** | *2.05* | 6.24 | 6.94 | 2.54 | 1.82 | **11 30** | *9.* | **9.48** | *8.* | 9.01 | **3.28** | *3.* | 2.79 | 5923 |
| 5932 | Read's Practical Potato Special......... | ...... | ...... | 1.08 | **1.08** | *0.83* | 3.02 | 2.67 | 1.91 | 1.00 | **5.58** | *5.* | **4.58** | *4.* | 4.33 | **8.38** | *8.* | 7.12 | 5932 |
| 5933 | R. C. Co.'s Essex XXX Fish & Pot.. | ...... | ...... | 2.50 | **2.50** | *2.1* | 7.00 | 6.67 | 2.87 | 3.64 | **13.18** | *12.* | **9.54** | *10.* | 9.76 | **2.32** | *2.25* | 1.97 | 5933 |
| 5620 | Standard Fertilizer......................... | 0.47 | ...... | 1.72 | **2.19** | *2.06* | 6.04 | 4.84 | 4.26 | 2.52 | **11.62** | *10.* | **9.10** | *8.* | 8.77 | **2.22** | *2.* | 1.89 | 5620 |
| 5929 | Tucker's Imperial for Corn............ | ...... | ...... | 1.32 | **1.32** | *1.23* | 3.70 | 5.82 | 2.76 | 1.81 | **10.39** | *11.* | **8.58** | *9.* | 8.17 | **2.30** | *1.85* | 1.96 | 5929 |
| 5930 | Tucker's Imperial for Potatoes........ | ...... | ...... | 1.53 | **1.53** | *1.23* | 4.28 | 5.71 | 2.93 | 1.90 | **10 54** | *11.* | **8.64** | *9.* | 8.24 | **2.47** | *1.85* | 2.10 | 5930 |
| 5907 | W. & C. Co.'s Americus Corn Phos.. | ...... | ...... | 2.13 | **2.13** | *2.06* | 5.96 | 5.91 | 3.89 | 2.15 | **11.95** | *10.* | **9.80** | *9.* | 9.29 | **1 76** | *1.5* | 1.50 | 5907 |
| 5905 | W. & C. Co.'s Americus Potato Man. | ...... | ...... | 2.14 | **2.14** | *2.06* | 5.99 | 6.01 | 3.12 | 2.65 | **11.78** | *9.* | **9.13** | *8.* | 8.97 | **3.29** | *3.* | 2.80 | 5905 |
| 5906 | W. & C. Co.'s Royal Bone Phos...... | ...... | ...... | 1.18 | **1.18** | *1.03* | 3.30 | 5.83 | 2.87 | 1.62 | **10.32** | *8.* | **8.70** | *7.* | 8.19 | **2.56** | *2.* | 2.18 | 5906 |

***Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.**

**† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers, pages 50-58.**

# UNIVERSITY OF VERMONT
# AND STATE AGRICULTURAL COLLEGE

# VERMONT AGRICULTURAL
# EXPERIMENT STATION

BURLINGTON, VT.

# BULLETIN No. 64

APRIL, 1898

## Analyses of Commercial Fertilizers

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1898.

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F. A. RICH, Veterinarian.
CASSIUS PECK, Farm Superintendent.
B. O. WHITE, Assistant Chemist.
C. H. JONES, Assistant Chemist.
W. A. ORTON, Assistant Botanist.
W. C. NORCROSS, Dairyman.
MARY A. BENSON, Stenographer.
E. H. POWELL, Treasurer.

☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the East.

# BULLETIN No. 64.

# ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills, B. O. White and C. H. Jones.

## I. STATEMENT REGARDING COLLECTION OF SAMPLES.

During February, March and early April, Messrs. D. H. Udall of Craftsbury, A. M. Vaughan of Woodstock and O. B. Wood of Georgia, agents of this station, visited 102 towns and villages in Vermont and drew 392 samples, representing 123 distinct brands of fertilizers. One hundred and thirty-four brands were found last year, 110 in 1896, 92 in 1895, 53 in 1894, and but 36 in 1893. This rapid increase is due to an actual increase in the number of brands sold, to an increase in the number of companies licensed and to our inability to make a thorough search prior to 1895.

It is believed that one or more samples of nearly every brand of fertilizer sold in the state have been secured this spring. The station desires that farmers, farmers' clubs and granges call its attention to brands of fertilizer on sale not included in this bulletin, either in the tables of analyses or the list of samples on hand. So far as is practicable goods thus reported will be sampled. It should be noted, however, that, as a rule, the station will not sample or analyze:

1. From stock of less than one ton.
2. From stock which has been carried over from a former season.
3. From stock which has been improperly stored.

Bulletin 63, distributed to the state mailing list March 29th, contained analyses of composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the state) of leading brands of goods made by each manufacturer then licensed to sell in the state. The present bulletin contains the analyses of composite samples of 84 distinct brands, the output of 18 manufacturers. The analysis of a composite sample certainly represents the average character of the goods more fairly than can the analysis of a single sample. The 36 analyses published in Bulletin 63 are reprinted to facilitate ready reference.

The 83 brands reported comprise all those of which two or more samples were found by the station agents. There is reason to believe that over 95 per cent of the trade in the state is confined to these brands.

The reader is referred to Bulletin 63 for details regarding the schedule of trade values and their application to superphosphates and mixed goods.

The values per pound of the ingredients as found in mixed goods are as follows: organic and ammoniacal nitrogen, 14 cents; nitrogen from nitrates, 13 cents; soluble, reverted and insoluble phosphoric acids, 4½, 4 and 2 cents respectively; potash, as sulphate, 5 cents, as muriate, 4¼ cents. It should be particularly noted, however, that **these trade values do not represent the proper selling prices of mixed goods at the point of consumption**, but are the retail trade values or cash-cost of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in standard unmixed raw materials of good quality, at the seaboard. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have a purely commercial significance.

The reader is also referred to Bulletins 47 and 59 for a full discussion of the principles and practice of fertilization, with suggestions concerning the selection, purchase and use of artificial fertilizers, and especially to the remarks on home mixing. These as well as other bulletins and reports will be sent to any address without charge, on application, as long as the supplies last.

## OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however, that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not affected by the restrictions of the law.

| License Number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | Box 3404, Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | Box 3404, Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | P. O. Drawer 142, Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co. | State St., and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |

| | | |
|---|---|---|
| 10 | E. Frank Coe Co | 133–137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 92 State St., Boston, Mass. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 17 | H. J. Baker & Bro | 93–97 William St., New York, N. Y. |
| 18 | Russia Cement Co | Gloucester, Mass. |

## II. LICENSED FERTILIZERS SAMPLED BY STATION.*

### H. J. Baker & Bro., New York, N. Y.

**6054. Complete Potato Manure**; from stock of G. Hinsdill, North Bennington.

**6051. Harvest Home Fertilizer**; from stock of B. T. Hewey, North Bennington.

### Bowker Fertilizer Co., Boston, Mass.

**6077. Farm and Garden Phosphate**; from stocks of Wm. C. Bugbee, Bridgewater; H. S. Annis, Chelsea.

**6076. Hill and Drill Phosphate**; from stocks of W. E. Granger, Williamstown; H. S. Annis, Chelsea; A. L. Aseltine, Swanton.

**6061. Potato Phosphate**; from stocks of H. G. Barnes, Bethel; G. H. Manchester, South Royalton; A. Whitcomb, Springfield.

**6060. Potato and Vegetable Phosphate;** from stocks of H. G. Barnes, Bethel; G. H. Manchester, South Royalton; K. T. Browne, Lunenburgh.

**6062. Stockbridge Manure for Corn**; from stocks of K. T. Browne, Lunenburgh; Wm. C. Bugbee, Bridgewater; H. G. Barnes, Bethel; A. Whitcomb, Springfield.

**6106. Stockbridge Manure for Top Dressing**; from stocks of H. Kelley, Bradford; A. E. Fuller, Woodstock; S. Kelley, West Burke; C. E. Perry, Newfane.

**6078. Sure Crop Phosphate**: from stocks of Wm. C. Bugbee, Bridgewater; H. S. Annis, Chelsea.

### Bradley Fertilizer Co., Boston, Mass.

**6063. Complete Manure for Top Dressing Grass and Grain**; from stocks of E. A. Morse, Calais; B. S. Hooker, Bradford.

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*The names and locations of agents from whom samples were taken which made analytical samples reported in Bulletin 63 and reprinted in this bulletin may be found on reference thereto.

**6081. Patent Superphosphate of Lime**; from stocks of D. Spooner, Randolph; W. B. Robinson, Chelsea; W. W. Coe, West Burke.

**6064. Vermonter for all Crops**; from stocks of S. Davis, Danville; Dutton & Richmond, Northfield; D. Spooner, Randolph.

### Clark's Cove Fertilizer Co., Boston, Mass.

**6088. King Philip Alkaline Guano**; from stocks of J. H. Hewitt, South Royalton; E. G. Jackson, Williamstown.

**6087. Potato Fertilizer**; from stocks of J. H. Hewitt, South Royalton; J. H. Silsby, Lunenburgh.

### Cleveland Dryer Co., Boston, Mass.

**6067. Fertilizer for all Crops**; from stocks of C. G. Wheeler, Worcester; M. A. Nelson, Montpelier; J. P. Telfer, Barton; C. L. Russell, Norwich; J. Chaffey, Enosburgh Falls; B. M. Ellinwood, Cambridge.

### E. Frank Coe Co., New York, N. Y.

**6091. Celebrated Special Grass and Grain Fertilizer**; from stocks of D. C. Smith & Son, Shelburne; F. A. Collins. St. Albans.

**6100. High Grade Ammoniated Bone Superphosphate**; from stocks of Adams & Alexander, Randolph Center; R. T. Ketcham, Sudbury.

**6070. Prize Brand Guano**; from stocks of Valley Grain Co., Brattleboro; E. R. Rising, Brandon.

**6071. XXV Ammoniated Bone Superphosphate**; from stocks of E. R. Rising, Brandon; E. S. Stratton, Craftsbury; Kent & Vinton, Montpelier.

### Crocker Fertilizer & Chemical Co., Boston, Mass.

**6072. Ammoniated Bone Superphosphate**; from stocks of F. Fuller, Montpelier; I. Benson, West Woodstock; E. A. Dutton, East Craftsbury.

**6093. Superior Fertilizer**; from stocks of C. M. Byington, Charlotte; D. C. Colburn, Mount Holly.

### Cumberland Bone Phosphate Co., Boston, Mass.

**6068. Fertilizer for all Crops**; from stocks of W. H. Nye, Johnson; H. Dunn, South Peacham; C. Gates & Sons, North Hartland.

**6089. Seeding Down Manure**; from stocks of W. H. Nye, Johnson; F. H. Frasier, West Burke.

### Great Eastern Fertilizer Co., Rutland, Vt.

**6069. Northern Corn Special**; from stocks of G. Dow, Cabot; G. Coffrin, East Calais; L. W. Holt, East Barnard; E. L. Winslow, Prosper; H. W. Towle, Enosburgh.

### Lister's Agricultural Chemical Works, Newark, N. J.

**6092. Animal Bone and Potash**; from stocks of S. Collins, Huntington; G. A. Chase, East St. Johnsbury.

**6073. Oneida Special**; from stocks of T. Gagney, St. Johnsbury; D. C. Smith & Son, Shelburne.

**6074. Special Corn Fertilizer**; from stocks of D. C. Smith & Son, Shelburne; G. A. Chase, East St. Johnsbury.

**6075. Special Potato Fertilizer**; from stocks of H. H. Ormsby, Bradford; J. Poor, Craftsbury.

### Lowell Fertilizer Co., Boston, Mass.

**6094. Animal Brand for all Crops**; from stocks of W. W. Sawyer, Alburgh; F. W. Strong, Montpelier.

**6095. Dissolved Bone and Potash**; from stocks of C. E. Silsby, West Burke; C. N. Lathrop, Williamstown; F. W. Strong, Montpelier; E. H. Sherwin, Johnson.

### Pacific Guano Co., Boston, Mass.

**6066. Potato Special**; from stocks of F. M. Partch, New Haven; O. L. Miner, Brattleboro; H. S. Taber, Montpelier; R. Pixley, Norwich.

### Quinnipiac Co., Boston, Mass.

**6065. Climax Phosphate for all Crops**; from stocks of Mellon & Proctor, Brattleboro; D. G. Butler, Montpelier; N. W. Bates, Essex Center.

**6097. Market Garden Manure**; from stocks of A. A. Dunklee, South Vernon; Mellon & Proctor, Brattleboro.

**6098. Mohawk Fertilizer**; from stocks of H. Ballard, East Poultney; N. M. Bachelder, Newfane.

**6099. Onion Manure**; from stocks of A. A. Dunklee, South Vernon; N. Dunn, Pownal.

### Read Fertilizer Co., New York, N. Y.

**6084. Farmers' Friend Superphosphate**; from stocks of A. M. Temple, Newport; P. Porter, West Burke.

**6104. Fish, Bone and Potash**; from stocks of M. W. Bruso, Barnet; J. T. McCall, Bennington; C. E. Gove, Burlington.

**6085. Leader Guano**; from stock of P. Porter, West Burke; C. W. Comstock, Barton.

**6103. Sampson Fertilizer for Potatoes**; from stocks of C. W. Comstock, Barton; C. E. Miller, South Ryegate.

**6083. Standard Superphosphate**; from stocks of W. N. Flynn, Underhill; C. P. Waite, Whiting; A. B. Yandow, Essex Junction; P. Porter, West Burke; W. G. White, Jonesville.

**6086. Sure Catch Fertilizer**; from stocks of C. W. Comstock, Barton; A. M. Temple, Newport.

**6105. Vegetable and Vine Fertilizer**; from stocks of J. T. McCall, Bennington; C. H. Myers, Pownal Center.

### Russia Cement Co., Gloucester, Mass.

**6079. Essex Complete Manure for Corn, Grain and Grass**; from stocks of G. H. Wilson, North Troy; C. K. Willard, East Montpelier.

**6080. Essex Complete Manure for Potatoes and Roots**; from stocks of G. H. Wilson, North Troy; J. C. Wilson, Craftsbury.

### Standard Fertilizer Co., Boston, Mass

**6101. Special for Potatoes**; from stocks of C. W. Atherton, Waterbury; H. L. Gilmore, Groton; L. H. Lamphier, Morrisville.

### Henry F. Tucker Co., Boston, Mass.

**6108. Special Potato Fertilizer**; from stocks of F. J. Libby, Newport; C. F. Wheeler, Worcester.

### Williams & Clark Co , Boston, Mass.

**6096. Americus Ammoniated Bone Superphosphate**; from stocks of R. W. Smith, West Townshend; M. V. Willard, Jericho Centre.

**6090. Prolific Crop Producer**; from stocks of Urie & Sawyer, Craftsbury; P. V. Cook, Leicester Junction.

### EXPLANATION OF TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers upon the next three pages show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 48 of Bulletin 63, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicised* type gives *guarantees*, the **black-faced** type gives the **most important figures found by analysis**.

# III ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton † | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton † | |
| ¶6054 | Baker's Complete Potato Manure..... | 0.77 | 1.74 | 1.05 | **3.56** | *3.3* | $9.82 | 5.15 | 2.00 | 1.14 | **8.29** | *6.75* | **7.15** | *5.75* | $6.68 | **10.35** | *10.* | $9.40 | 6054 |
| 6051 | Baker's Harvest Home Fertilizer..... | ...... | 0.32 | 1.02 | **1.34** | *1.03* | 3.75 | 5.10 | 4.01 | 1.99 | **11.10** | *9.* | **9.11** | *8.* | 8.60 | **3.07** | *2.* | 2.61 | 6051 |
| ‡5921 | Bowker's Corn Phosphate............. | 0.42 | ...... | 1.51 | **1.93** | *1.5* | 5.32 | 5.25 | 3.22 | 2.07 | **10.54** | *11.* | **8.47** | *9.* | 8.13 | **2.34** | *2.* | 1.98 | 5921 |
| 6077 | Bowker's Farm and Garden Phos... | 0.51 | ...... | 1.30 | **1.81** | *1.6* | 4.97 | 5.52 | 3.16 | 2.84 | **11.52** | *10.* | **8.68** | *8.* | 8.63 | **2.44** | *2.* | 2.07 | 6077 |
| 6076 | Bowker's Hill and Drill Phosphate.. | 0.64 | ...... | 2.05 | **2.69** | *2.25* | 7.40 | 6.81 | 3.05 | 2.27 | **12.13** | *12.* | **9.86** | *9.* | 9.48 | **2.47** | *2.* | 2.10 | 6076 |
| 6061 | Bowker's Potash Phosphate........... | 0.23 | ...... | 0.86 | **1.09** | *0.75* | 3.01 | 2.64 | 5.46 | 2.94 | **11.04** | *10.* | **8.10** | *8.* | 7.92 | **3.35** | *3.* | 2.85 | 6061 |
| 6060 | Bowker's Potato and Veg. Phos...... | 0.42 | ...... | 1.45 | **1.87** | *1.5* | 5.15 | 5.37 | 3.29 | 1.90 | **10.56** | *10.* | **8.66** | *8.* | 8.22 | **2.27** | *2.* | 1.93 | 6060 |
| 6062 | Bowker's Stockbridge Corn Manure | 1.43 | ...... | 2.07 | **3.50** | *3.* | 9.52 | 5.85 | 3.26 | 2.12 | **11.23** | *10.* | **9.11** | *8.* | 8.72 | **7.54** | *6.* | 6.41 | 6062 |
| ‡5920 | Bowker's Stockbridge Potato Man... | 1.21 | ...... | 2.27 | **3.48** | *3.2* | 9.51 | 5.15 | 2.44 | 1.66 | **9.25** | *7.* | **7.59** | *5.* | 7.25 | **10.26** | *10.* | 8.72 | 5920 |
| 6106 | Bowker's Stockbridge Top Dr's'g M. | 2.83 | ...... | 2.18 | **5.01** | *4.75* | 13.46 | 4.49 | 2.23 | 2.05 | **8.77** | *6.* | **6.72** | *4.* | 6.64 | **6.63** | *6.* | 5.64 | 6106 |
| 6078 | Bowker's Sure Crop Phosphate........ | 0.19 | ...... | 0.80 | **0.99** | *0.75* | 2.73 | 6.46 | 4.04 | 2.77 | **13.27** | *10.* | **10.50** | *8.* | 10.15 | **1.19** | *1.* | 1.01 | 6078 |
| ‡5919 | Bowker's Vermont Phosphate......... | 0.96 | ...... | 1.60 | **2.56** | *1.75* | 6.98 | 6.63 | 2.78 | 1.28 | **10.69** | *10.* | **9.41** | *8.* | 8.70 | **4.58** | *3.* | 3.89 | 5919 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50-52 of Bulletin 63. ‡ Reprinted from Bulletin 63. ¶Potash partly as sulphate.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| *6063 | Bradley's Complete Top Dressing | 4.96 | ...... | 0.12 | **5.08** | *4.95* | $13.24 | 3.52 | 3.60 | 0.86 | **7.98** | *6.* | **7.12** | *5.* | $6.39 | **2.85** | *2.5* | $2.78 | 6063 |
| ‡5910 | Bradley's Corn Phosphate | ...... | ...... | 2.07 | **2.07** | *2.06* | 5.80 | 5.67 | 4.09 | 2.82 | **12.58** | *10.* | **9.76** | *9.* | 9.50 | **1.74** | *1.5* | 1.48 | 5910 |
| ‡5912 | Bradley's Eclipse Phosphate | ...... | ...... | 1.67 | **1.67** | *1.* | 4.68 | 5.30 | 5.18 | 2.60 | **13.08** | *12.* | **10.48** | *10.* | 9.95 | **1.78** | *1.5* | 1.51 | 5912 |
| 6081 | Bradley's Patent Superphosphate | ...... | ...... | 2.52 | **2.52** | *2.05* | 7.06 | 6.68 | 3.43 | 1.98 | **12.09** | *11.* | **10.11** | *9.* | 9.55 | **2.16** | *2.* | 1.84 | 6081 |
| ‡5911 | Bradley's Potato Fertilizer | ...... | ...... | 2.18 | **2.18** | *2.06* | 6.10 | 5.99 | 3.08 | 2.49 | **11.56** | *11.* | **9.07** | *9.* | 8.85 | **3.49** | *3.25* | 2.97 | 5911 |
| 6064 | Bradley's Vermonter for All Crops | ...... | ...... | 2.11 | **2.11** | *2.06* | 5.91 | 6.80 | 2.97 | 1.65 | **11.42** | *10.* | **9.79** | *8.* | 9.16 | **4.60** | *3.5* | 3.91 | 6064 |
| ‡5909 | Bradley's XL Superphosphate | ...... | ...... | 2.52 | **2.52** | *2.5* | 7.06 | 6.72 | 3.78 | 1.85 | **12.35** | *11.* | **10.50** | *9.* | 9.81 | **2.08** | *2.* | 1.77 | 5909 |
| ‡5937 | Clark's Cove Bay State Fert. G. G. | ...... | ...... | 2.15 | **2.15** | *1.85* | 6.02 | 5.34 | 3.87 | 2.51 | **11.72** | *10.* | **9.21** | *8.5* | 8.91 | **2.37** | *2.* | 2.01 | 5937 |
| 6088 | Clark's Cove King Philip Alk. Gua. | ...... | ...... | 1.20 | **1.20** | *1.03* | 3.36 | 5.85 | 2.82 | 1.91 | **10.58** | *9.* | **8.67** | *8.* | 8.28 | **2.36** | *2.* | 2.01 | 6088 |
| 6087 | Clark's Cove Potato Fertilizer | ...... | ...... | 2.11 | **2.11** | *2.06* | 5.91 | 4.68 | 3.84 | 3.10 | **11.62** | *9.* | **8.52** | *8.* | 8.53 | **2.96** | *3.* | 2.51 | 6087 |
| ‡5913 | Cleveland Corn and Grain Phos. | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.41 | 3.97 | 3.01 | **12.39** | *10.5* | **9.38** | *9.5* | 9.25 | **1.60** | *1.5* | 1.36 | 5913 |
| 6067 | Cleveland Fertilizer for All Crops | ...... | ...... | 1.16 | **1.16** | *1.03* | 3.25 | 5.94 | 2.51 | 1.76 | **10.21** | *9.* | **8.45** | *8.* | 8.06 | **2.33** | *2.* | 1.98 | 6067 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50-52 of Bulletin 63. ‡Reprinted from Bulletin 63.

# ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| ‡5914 | Cleveland Potato Phosphate | ...... | ...... | 2.11 | **2.11** | *2.06* | $5.91 | 5.63 | 3.24 | 3.02 | **11 89** | *10.* | **8.87** | *8.* | $ 8.87 | **3.30** | *3.* | $2.81 | 5914 |
| *6091 | Coe's Cel. Spec. Grass and Grain | ...... | ...... | 1.13 | **1.13** | *0.83* | 3.16 | 7.52 | 3.63 | 2.35 | **13 50** | *10.* | **11.15** | *9.* | 10.61 | **1.81** | *1.35* | 1.76 | 6091 |
| *‡5917 | Coe's Columbian Corn Fertilizer | ...... | ...... | 1.51 | **1.51** | *1.23* | 4.23 | 7.46 | 3.37 | 2.37 | **13.20** | *11.* | **10.83** | *9.* | 10.36 | **2.06** | *1.85* | 2.06 | 5917 |
| *‡5918 | Coe's Columbian Potato Fertilizer | ...... | ...... | 1.53 | **1.53** | *1.23* | 4.28 | 7.48 | 3.16 | 2.42 | **13 06** | *11.* | **10.64** | *9.* | 10.23 | **1.98** | *1.85* | 1 98 | 5918 |
| *6100 | Coe's H. G. Ammo. Bone Superphos | ...... | 0.22 | 1.97 | **2 19** | *2.06* | 6.13 | 6.94 | 3.22 | 1.78 | **11 94** | *11.* | **10.16** | *9.* | 9.54 | **2.30** | *1.85* | 2.30 | 6100 |
| *6070 | Coe's Prize Brand Guano | ...... | ...... | 0.73 | **0 73** | *0.41* | 2.04 | 8.00 | 3.92 | 2.91 | **14 83** | *12.* | **11 92** | *10.5* | 11.50 | **1.18** | *1.25* | 1.16 | 6070 |
| *6071 | Coe's XXV Ammo. Bone Superphos | ...... | ...... | 1.16 | **1.16** | *1.* | 3.25 | 7.50 | 4.11 | 2.30 | **13 91** | *9.* | **11.61** | *8.* | 10.96 | **1.03** | *1.* | 1.01 | 6071 |
| 6072 | Crocker's Ammo. Bone Superphos | ...... | ...... | 3.13 | **3.13** | *2.9* | 8.76 | 6.69 | 3.97 | 1.15 | **11.81** | *11.* | **10.66** | *10.* | 9.66 | **1.19** | *1.08* | 1.01 | 6072 |
| ‡5927 | Crocker's Ammo. Corn Phosphate | ...... | ...... | 2.09 | **2.09** | *2.* | 5.85 | 6.54 | 3.59 | 1.19 | **11.32** | *11.* | **10.13** | *10.* | 9.23 | **1.87** | *1.6* | 1.59 | 5927 |
| ‡5926 | Crocker's New Rival Ammo. Bone | ...... | ...... | 1.32 | **1.32** | *1.23* | 3.70 | 6.02 | 4.45 | 1.56 | **12.03** | *11.* | **10.47** | *10.* | 9.60 | **1.80** | *1.6* | 1.53 | 5926 |
| ‡5928 | Crocker's Potato, Hop and Tobacco | ...... | ...... | 2.28 | **2 28** | *2.* | 6.38 | 6.89 | 3.11 | 1.23 | **11.23** | *11.* | **10.00** | *10.* | 9.18 | **3.32** | *3.25* | 2.82 | 5928 |
| ¶6093 | Crocker's Superior Fertilizer | ...... | ...... | 0.85 | **0.85** | *0.82* | 2.38 | 4.24 | 3.93 | 1.17 | **9 34** | *9.* | **8.17** | *8.* | 7.43 | **2.10** | *2.* | 1.79 | 6093 |

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¶ This brand is likewise sold as "Superior Rye and Oats Fertilizer."

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| 6068 | Cumberland Fertilizer for all Crops...... | ...... | ...... | 1.10 | **1.10** | *1.03* | $ 3.08 | 5.79 | 2.68 | 1.93 | **10.40** | *10.* | **8.47** | *8.* | $ 8.13 | **2.33** | *2.* | $1.98 | 6068 |
| ‡5916 | Cumberland Potato Fertilizer.......... | 0.30 | ...... | 1.77 | **2.07** | *2.06* | 5.74 | 4.62 | 4.52 | 3.02 | **12.16** | *11.* | **9.14** | *9.* | 8.98 | **2.98** | *3.* | 2.53 | 5916 |
| 6089 | Cumberland Seeding Down Manure. | ...... | ...... | 1.16 | **1.16** | *1.03* | 3.25 | 5.82 | 2.67 | 1.91 | **10.40** | *10.* | **8.49** | *8.* | 8.14 | **2 46** | *2.* | 2.09 | 6089 |
| ‡5915 | Cumberland Superphosphate........... | 0.34 | ...... | 1.92 | **2.26** | *2.06* | 6.26 | 6.02 | 4.08 | 2.02 | **12.12** | *10.* | **10.10** | *8.* | 9.49 | **2 22** | *2.* | 1.89 | 5915 |
| ‡5936 | Great Eastern General Fertilizer...... | ...... | ...... | 1.05 | **1.05** | *0.82* | 2.94 | 6.36 | 2.36 | 1.01 | **9.73** | *9.* | **8.72** | *8.* | 8.02 | **4.37** | *4.* | 3.71 | 5936 |
| ‡5935 | Great Eastern Grass and Oats Fert... | ...... | ...... | ...... | ...... | ...... | ......... | 7.14 | 3.64 | 1.31 | **12.09** | *12.* | **10.78** | *11.* | 9.86 | **2.10** | *2.* | 1.78 | 5935 |
| 6069 | Great Eastern Northern Corn Special | ...... | 0.27 | 2.79 | **3.06** | *3.* | 8.57 | 6.58 | 2.49 | 1.36 | **10.43** | *9.* | **9.07** | *8.* | 8.46 | **2.29** | *2.* | 1.95 | 6069 |
| ‡5934 | Great Eastern Potato Manure.......... | ...... | ...... | 2.38 | **2.38** | *2.06* | 6.66 | 6.03 | 2.40 | 2.00 | **10.43** | *9.* | **8.43** | *8.* | 8.15 | **4.28** | *4.* | 3.64 | 5934 |
| 6092 | Lister's Animal Bone and Potash..... | ...... | ...... | ...... | ...... | ...... | ......... | 6.58 | 3.07 | 0.58 | **10.23** | *10.* | **9.65** | *9.* | 8.61 | **4.90** | *5.* | 4.15 | 6092 |
| *6073 | Lister's Oneida Special.................. | ...... | ...... | 0.91 | **0.91** | *0.62* | 2.55 | 8.69 | 2.06 | 1.25 | **12.00** | *11.* | **10.75** | *10.* | 9.97 | **1.12** | *1.* | 1.10 | 6073 |
| ¶‡5904 | Lister's Special Potato Fertilizer....... | ...... | 0.19 | 1.60 | **1.79** | *1.65* | 5.01 | 6.25 | 2.61 | 2.01 | **10.87** | *9.* | **8.86** | *8.* | 8.52 | **3 30** | *3.* | 2.90 | 5904 |
| §6075 | Lister's Special Potato Fertilizer...... | ...... | ...... | 1.82 | **1.82** | *1.65* | 5.10 | 5.94 | 2.88 | 2.30 | **11.12** | *9.* | **8.82** | *8.* | 8.57 | **3 04** | *3.* | 2.58 | 6075 |

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§Second sample analysed through inadvertence.

# ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| ¶†6074 | Lister's Special Corn Fertilizer........ | ...... | ...... | 1.80 | **1.80** | *1.65* | $5.04 | 6.29 | 2.60 | 2.21 | **11.10** | *9.* | **8.89** | *8.* | $8.63 | **3 05** | *3.* | $2.67 | 6074 |
| ‡5903 | Lister's Success Fertilizer............... | ...... | 0.19 | 1.26 | **1.45** | *1.24* | 4.06 | 7.25 | 2.74 | 1.89 | **11.88** | *11.5* | **9.99** | *9.5* | 9.47 | **2 36** | *2.* | 2.01 | 5903 |
| 6094 | Lowell Swift's Animal Brand......... | ...... | ...... | 2.59 | **2.59** | *2.47* | 7.25 | 5.89 | 3.19 | 1.74 | **10.82** | *10.* | **9.08** | *9.* | 8.55 | **4.05** | *4.* | 3.44 | 6094 |
| ‡5908 | Lowell Swift's Bone Fertilizer. ....... | ...... | ...... | 1.79 | **1.79** | *1.65* | 5.01 | 5.08 | 3.23 | 1.71 | **10.02** | *9.* | **8.31** | *8.* | 7.84 | **3.33** | *3.* | 2.83 | 5908 |
| 6095 | Lowell Swift's D. Bone and Potash.. | ...... | ...... | 1.91 | **1.91** | *1.65* | 5.35 | 6.47 | 2.58 | 2.18 | **11.23** | *10.* | **9.05** | *9.* | 8.76 | **2.24** | *2.* | 1.90 | 6095 |
| *‡5931 | Lowell Swift's Potato Phosphate..... | ...... | 0.19 | 2.67 | **2.86** | *2.47* | 8.01 | 4.85 | 3.80 | 1.43 | **10.08** | *9.* | **8.65** | *8.* | 7.98 | **6.08** | *6.* | 5.94 | 5931 |
| ‡5925 | P. G. Co.'s Nobsque Guano............... | ...... | ...... | 1.16 | **1.16** | *1.15* | 3.25 | 5.70 | 2.81 | 1.82 | **10.33** | *9.* | **8.51** | *8.* | 8.11 | **2.11** | *2.* | 1.79 | 5925 |
| 6065 | P. G. Co.'s Potato Special............... | ...... | ...... | 2.09 | **2.09** | *2.06* | 5.85 | 6.28 | 3.09 | 2.41 | **11.78** | *9.* | **9.38** | *8.* | 9.09 | **3.22** | *3.* | 2.74 | 6065 |
| ‡5924 | P. G. Co.'s Soluble Pacific Guano..... | ...... | ...... | 2.13 | **2.13** | *2.25* | 5.96 | 4.87 | 4.53 | 2.21 | **11.61** | *10.5* | **9.40** | *8.5* | 8.89 | **2.21** | *2.* | 1.88 | 5924 |
| 6066 | Quinnipiac Climax Phosphate.......... | ...... | ...... | 1.24 | **1.24** | *1.03* | 3.47 | 5.75 | 2.94 | 2.12 | **10.81** | *9.* | **8 69** | *8.* | 8.38 | **2 25** | *2.* | 1.91 | 6066 |
| ‡5922 | Quinnipiac Corn Manure................. | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.86 | 3.93 | 2.14 | **11.93** | *10.* | **9.79** | *9.* | 9.27 | **1.63** | *1.5* | 1.39 | 5922 |
| 6097 | Quinnipiac Market Garden Manure.. | 0.46 | 0.61 | 2.50 | **3.57** | *3.3* | 9.90 | 5.07 | 3.59 | 1.77 | **10.43** | *9.* | **8.66** | *8.* | 6.71 | **7.48** | *7.* | 6.36 | 6097 |

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## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found * | Guaranteed | Valuation of Potash in One Ton† | |
| 6098 | Quinnipiac Mohawk Fertilizer........ | ...... | ...... | 1.17 | **1.17** | *0.82* | $ 3.28 | 3.64 | 4.22 | 2.80 | **10.66** | *8.* | **7.86** | 7. | $7.78 | **1.48** | *1.* | $1.26 | 6098 |
| 6099 | Quinnipiac Onion Manure.............. | 1.27 | 0.19 | 1.93 | **3.39** | *3.3* | 9.24 | 4.30 | 4.16 | 1.81 | **10.27** | *9.* | **8.46** | *8.* | 7.92 | **7.48** | 7. | 6.36 | 6099 |
| ‡5923 | Quinnipiac Potato Phosphate......... | ...... | ...... | 2.23 | **2.23** | *2.05* | 6.24 | 6.94 | 2.54 | 1.82 | **11.30** | *9.* | **9.48** | *8.* | 9.01 | **3.28** | *3.* | 2.79 | 5923 |
| 6084 | Read's Farmers' Friend Superphos.. | ...... | ...... | 2.39 | **2.39** | *2.1* | 6.69 | 7.72 | 2.39 | 1.22 | **11.33** | *10.* | **10.11** | *9.* | 9.35 | **2.60** | *2.* | 2.21 | 6084 |
| 6104 | Read's Fish, Bone and Potash......... | ...... | ...... | 2.30 | **2.30** | *2.47* | 6.44 | 2.29 | 2.11 | 2.52 | **6.92** | *5.* | **4.44** | *4.* | 4.76 | **4.31** | *4.* | 3.66 | 6104 |
| 6085 | Read's Leader Guano.................... | ...... | ...... | 1.13 | **1.13** | *0.83* | 3.16 | 4.84 | 2.43 | 1.28 | **8.55** | *8.* | **7.27** | 7. | 6.81 | **2.30** | *2.* | 1.95 | 6085 |
| ‡5933 | Read's Practical Potato Special........ | ...... | ...... | 1.08 | **1.08** | *0.83* | 3.02 | 2.67 | 1.91 | 1.00 | **5.58** | *5.* | **4.58** | *4.* | 4.33 | **8.38** | *8.* | 7.12 | 5933 |
| 6103 | Read's Sampson for Potatoes........... | ...... | ...... | 2.32 | **2.32** | *1.65* | 6.50 | 5.84 | 2.52 | 1.46 | **9.82** | 7. | **8.36** | *6.* | 7.86 | **4.82** | *4.* | 4.10 | 6103 |
| 6083 | Read's Standard Superphosphate..... | ...... | ...... | 1.09 | **1.09** | *0.83* | 3.05 | 6.15 | 2.57 | 1.13 | **9.85** | *9.* | **8.72** | *8.* | 8.04 | **4.02** | *4.* | 3.42 | 6083 |
| 6086 | Read's Sure Catch Fertilizer........... | ...... | ...... | ...... | ...... | ...... | ......... | 3.61 | 3.55 | 1.00 | **8.16** | 7. | **7.16** | *6.* | 6.49 | **4.06** | *4.* | 3.45 | 6086 |
| 6105 | Read's Vegetable and Vine Fert...... | ...... | ...... | 1.91 | **1.91** | *1.65* | 5.35 | 4.34 | 2.08 | 1.74 | **8.16** | 7. | **6.42** | *6.* | 6.27 | **8.41** | *8.* | 7.15 | 6105 |
| 6079 | R. C. Co.'s Essex, Corn, Grain, Grass | 0.65 | ...... | 3.63 | **4.28** | *3.7* | 11.85 | 3.77 | 4.74 | 3.11 | **11.62** | *9.5* | **8.51** | 7. | 8.43 | **9.89** | *9.5* | 8.41 | 6079 |

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## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total Found | Total Guaranteed | Available Found | Available Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| *6080 | R. C. Co.'s Essex, Potatoes & Roots | 0.40 | 0.53 | 3.45 | **4.38** | *3.7* | $12.08 | 3.64 | 4.95 | 2.45 | **11 04** | *9.* | **8.59** | *7.* | $8.22 | **8.90** | *8.5* | $8.82 | 6080 |
| ‡5933 | R. C. Co.'s Essex XXX Fish & Pot.. | ...... | ...... | 2.50 | **2.50** | *2.1* | 7.00 | 6.67 | 2.87 | 3.64 | **13.18** | *12.* | **9.54** | *10.* | 9.76 | **2.32** | *2.25* | 1.97 | 5933 |
| ‡5620 | Standard Fertilizer ........................ | 0.47 | ...... | 1.72 | **2.19** | *2.06* | 6.04 | 4.84 | 4.26 | 2.52 | **11.62** | *10.* | **9.10** | *8.* | 8.77 | **2.22** | *2.* | 1.89 | 5620 |
| 6101 | Standard Special for Potatoes ......... | ...... | ...... | 2.09 | **2.09** | *2.05* | 5.85 | 7.00 | 2.67 | 1.82 | **11.49** | *9.* | **9.67** | *8.* | 9.17 | **3.36** | *3.* | 2.86 | 6101 |
| ‡5929 | Tucker's Imperial for Corn.............. | ...... | ...... | 1.32 | **1 32** | *1.23* | 3.70 | 5 82 | 2.76 | 1.81 | **10.39** | *11.* | **8 58** | *9.* | 8.17 | **2.30** | *1.85* | 1.96 | 5929 |
| ‡5930 | Tucker's Imperial for Potatoes ........ | ...... | ...... | 1.53 | **1 53** | *1.23* | 4.28 | 5.71 | 2.93 | 1.90 | **10.54** | *11.* | **8.64** | *9.* | 8.24 | **2.47** | *1.85* | 2.10 | 5930 |
| 6108 | Tucker's Special Potato Fertilizer..... | ...... | ...... | 2.22 | **2.22** | *2.4* | 6.22 | 2.72 | 4.24 | 3.38 | **10 34** | *9.* | **6.96** | *8.* | 7.19 | **5 83** | *6.* | 4.96 | 6108 |
| 6096 | W. & C. Co 's Amer. A. B. Superph.. | ...... | ...... | 2.57 | **2.57** | *2.47* | 7.20 | 6.72 | 3.64 | 1.96 | **12.32** | *10.* | **10.36** | *9.* | 9.74 | **2.29** | *2.* | 1.95 | 6096 |
| ‡5907 | W. & C. Co.'s Americus Corn Phos.. | ...... | ...... | 2.13 | **2.13** | *2.06* | 5.96 | 5.91 | 3.89 | 2.15 | **11.95** | *10.* | **9.80** | *9.* | 9.29 | **1.76** | *1.5* | 1.50 | 5907 |
| ‡5905 | W. & C. Co.'s Americus Potato Man | ...... | ...... | 2.14 | **2 14** | *2.06* | 5.99 | 6.01 | 3.12 | 2.65 | **11 78** | *9.* | **9.13** | *8.* | 8.97 | **3.29** | *3.* | 2.80 | 5905 |
| 6090 | W. & C. Co.'s Prolific Crop Producer | ...... | ...... | 1.16 | **1 16** | *0.82* | 3.25 | 3.57 | 4.39 | 2.76 | **10 72** | *7.* | **7.96** | *6.* | 7.83 | **1.34** | *1.* | 1.14 | 6090 |
| ‡5906 | W. & C. Co.'s Royal Bone Phos ...... | ...... | ...... | 1.18 | **1 18** | *1.03* | 3.30 | 5.83 | 2.87 | 1.62 | **10.32** | *8.* | **8.70** | *7.* | 8.19 | **2 56** | *2.* | 2.18 | 5906 |

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## IV. BRANDS NOT REPORTED IN THIS BULLETIN.

Samples of the following brands are in the laboratory and their analyses will be published on completion in Bulletin 65. In no case has more than one sample of each of these brands been found by the station agents.

H. J. BAKER & BRO., New York, N. Y.
Cabbage Manure.
Complete Manure for General Use.
Complete Grass Manure.
Complete Nitrogenized Manure.
Complete Onion Manure.
Complete Potato and Vegetable Manure.
Standard UNXLD Fertilizer.

BOWKER FERTILIZER Co., Boston, Mass.
Market Garden Fertilizer.
Potash Bone.
Potash or Staple Phosphate.
Stockbridge Manure for Seeding Down.
Stockbridge Manure for Strawberries.
Stockbridge Manure for Vegetable and Potatoes.
Vermont Grange Chemicals, D. Brand.

BRADLEY FERTILIZER Co., Boston, Mass.
Complete Manure with 10 per cent Potash.
Potato Manure.
Seeding Down Fertilizer.

CLEVELAND DRYER Co., Boston, Mass.
High Grade Complete Manure.
Pioneer Fertilizer.
Seeding Down Fertilizer.
Superphosphate.

E. FRANK COE Co., New York, N. Y.
Celebrated Special Potato Fertilizer.
Columbian Ammoniated Bone Superphosphate.
New England Special for Corn.
New England Special for Potatoes.
Original New England Brand Tobacco Fertilizer.
Red Brand Excelsior Guano.
Seeding Down and Top Dressing Fertilizer.

CROCKER FERTILIZER AND CHEMICAL Co., Buffalo, N. Y.
Special Potato Manure.

LISTER'S AGRICULTURAL CHEMICAL WORKS, Newark, N. J.
Potato Manure.

PACIFIC GUANO Co., Boston, Mass.
Dissolved Bone and Potash.

QUINNIPIAC Co., Boston, Mass.
Phosphate.

RUSSIA CEMENT Co., Gloucester, Mass.
High Grade Superphosphate.

STANDARD FERTILIZER Co., Boston, Mass.
Guano for all Crops.

HENRY F. TUCKER Co., Boston, Mass.
Imperial Bone Superphosphate for all Crops.
Original Bay State Bone Superphosphate.

WILLIAMS & CLARK FERTILIZER Co., New York, N. Y.
High Grade Special for Potatoes, Onions, Tobacco, Cabbage and Cauliflower.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 65

MAY, 1898

# Analyses of Commercial Fertilizers

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1898.

# ORGANIZATION

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

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Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the East.

# BULLETIN NO. 65.

# ANALYSES OF COMMERCIAL FERTILIZERS.

BY J. L. HILLS, B. O. WHITE AND C. H. JONES.

## I. SUMMARY.

II and IV. The station has analyzed samples of 126 brands, the output of 18 companies, all drawn from dealers' stocks. all this year's goods. Three-quarters of the total number were above guarantee in every respect, nine-tenths were essentially equal to or better than guarantee and all afforded the commercial equivalent of their guarantees. Thirteen brands fell short more than 0.20 per cent in one ingredient, and two were lacking in two ingredients. In neither case were both ingredients seriously deficient. The application of pepsin digestion and alkaline-permanganate distillation methods to the several brands indicated that the quality of the organic nitrogen of about a dozen brands, notably the output of 2 concerns, was somewhat questionable. One hundred and five brands were guaranteed (directly or inferentially) to contain potash as sulphate, a claim which was verified in but 19 cases.

The average "valuation" was found to be $17.45 and the average selling price $29.04. Two dollars out of every five invested in fertilizers paid for costs of manufacture and sale. A dollar spent for average low priced goods (below $28) bought 58 cents worth of plant food; a dollar invested in average medium grade brands ($28 to $32), 60 cents worth; and a dollar paid out for average high priced goods ($32.50 and upwards), 67 cents worth. A dollar bought 79 cents worth of plant food in one brand and but 39 cents worth in another. A fifth of the entire number of brands sold furnished less than 55 cents worth of plant food for a dollar. (Pages 80-107.)

V. The average composition of the goods has not varied materially from that of last year. Selling prices are the same, plant food in mixed goods is as cheap as it ever was, but owing to the low prices of raw materials the practise of home mixing is proportionately more profitable now than hitherto. (Pages 108-110.)

VI. Home mixtures made in this state furnished from 30 to 50 per cent more plant food at the same cost than did average manufacturers mixtures. (Pages 110-118.)

## II. RESULTS OF INSPECTION.

### COLLECTION OF SAMPLES.

The sampling agents of the station visited 105 towns and villages in Vermont during the spring of 1898, and drew 405 samples from dealers' stocks, representing 126 distinct brands, the output of 18 companies licensed to sell in Vermont. It is thought that every brand sold in the state this spring, with one exception, has been sampled and analyzed. 134 brands were found in 1897, 110 in 1896, 92 in 1895, 53 in 1894, and but 36 in 1893. This rapid increase is mainly due to the larger trade in commercial fertilizers in recent years, which, according to the statistics taken by this station in 1896,* approximates 13,000 tons yearly. It is gratifying to note that this expansion in the number of brands seems to be checked. A large number of brands is neither necessary nor desirable from the farmer's standpoint, however helpful it may be to the manufacturer in meeting business competition. It is confusing to the buyer, and hinders rather than favors rational choice.

Several samples of crude stock were drawn by the sampling agents and many have been sent to the station for analysis during the course of the year. The analyses of these materials appear on pages 118–122 of the present bulletin. The samples of mixed goods and of crude stock, etc. analyzed number 228. They are classified in the following table. The pages of this bulletin upon which analyses of each kind of fertilizer and the discussion thereof appear are indicated in parentheses.

| | | |
|---|---|---|
| Nitrogenous superphosphates with potash | 122 | |
| Superphosphates with potash | 5 | |
| Total commercial mixed brands | 127 | (pages 97-107) |
| "Home mixtures," | 16 | ( " 112) |
| Nitrate of soda | 9 | ( " 118) |
| Cottonseed meals | 12 | ( " 119) |
| Bone meals, tankage, fish scrap, etc | 14 | ( " 120) |
| Acid phosphate, etc | 10 | ( " 121) |
| Potash salts | 17 | ( " 122) |
| Ashes | 21 | ( " 123) |
| Miscellaneous | 2 | ( " 112) |
| | 228 | |

### SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this state in 1898 is the one agreed upon by the experiment stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, after a careful study of prices ruling in the large markets of the southern New England and the Middle States. For comparative purposes the schedule used last year is included in the tabulation.

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*Rpt. Vt. Exp. Sta. 9 (1895), pp. 43-44.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1897 AND 1898.

| | 1897 cts. per lb. | 1898 cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 13½ | 14 |
| “ in nitrates | 14 | 13 |
| Organic nitrogen in dry and fine ground fish, blood and meat and in mixed fertilizers | 14 | 14 |
| “ “ in fine ground bone and tankage | 13½ | 13½ |
| “ “ in medium bone and tankage | 11 | 10 |
| “ “ in coarse bone and tankage | 8 | |
| Phosphoric acid soluble in water | 5½ | 4½ |
| “ “ “ in ammonium citrate* | 5 | 4 |
| “ “ in fine ground bone and tankage | 5 | 4 |
| “ “ in medium bone and tankage | 4 | 3½ |
| “ “ in coarse bone and tankage | 2½ | |
| “ “ insoluble (in ammonium citrate) in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate (or chlorids) | 5 | 5 |
| Potash as muriate | 4½ | 4½ |

The above trade values are, as nearly as can be estimated, the average figures at which, in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, (Boston, New York, etc.,) in the *raw materials*, unmixed. They also correspond (except in the case of available phosphoric acid) to the average wholesale prices for six months ending March 1st, plus about 20 per cent in the case of goods for which there are wholesale quotations.

In applying trade values to mixed goods, organic nitrogen is valued at 14 cents a pound; nitrogen as nitrate of soda and as sulphate of ammonia at 13 and 14 cents a pound respectively; soluble, reverted and insoluble phosphoric acids at 4½, 4 and 2 cents a pound respectively; potash at 4½ cents a pound, if there is sufficient chlorin to unite with all the potash, if not it is valued at 5 cents.

The "station valuation" is obtained by *multiplying the given per cent of each constituent* (*nitrogen, soluble, reverted and insoluble phosphoric acids and potash*) *by its trade value, adding the products and multiplying the sum by 20.*

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*Dissolved from 2 grams of the unground phosphate, previously extracted with pure water, by 100 c. c. of a neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes at 65 degrees C., with agitation once in five minutes; commonly called "reverted," or "backgone" phosphoric acid.

### OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however, that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not affected by the restrictions of the law.

| License number. | NAME OF COMPANY. | ADDRESS. |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | Box 3404, Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | Box 3404, Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | P. O. Drawer 142, Buffalo, N.Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phos. Co., | State St. and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133-137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 92 State St., Boston, Mass. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 17 | H. J. Baker & Bro | 93-97 William St., New York, N. Y. |
| 18 | Russia Cement Co | Gloucester, Mass. |

### BULLETINS 63, 64 AND 65.

Section 4355 of the Vermont Statutes makes it the duty of the director of the station to have "one analysis . . . of each fertilizer . . . made annually and the result published monthly." The early shipments made into this state enable the station to analyze and publish in March, April and May. The analyses of the brands which seem to be in most common use are printed in the March and April bulletins, thus becoming available as an aid in choice for purchase.

Bulletin 63 distributed to the state mailing list March 29th, contained 36 analyses made upon composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the state) of leading brands of goods made by 17 manufacturers. Bulletin 64, distributed to the state mailing list April 25th, contained the analyses of composite samples of 83 brands, the output of 18 manufacturers.

The brands reported in Bulletins 63 and 64 comprise all those of which two or more samples were found by the station agents. There is reason to believe that fully 95 per cent of the trade in the state is confined to these brands. These analyses, with 43 more, are grouped alphabetically by manufacturers' names in the present bulletin, which covers as completely as may be the fertilizer business of the present year.

### 1. GUARANTEES AND ANALYSES.

*Over three-fourths* (97 in 126) of the brands analyzed were found to be above guarantee in nitrogen, available phosphoric acid and potash. Of the 29 brands found lacking 14 showed a shortage of less than 0.20 per cent in a single ingredient, and 2 a total deficiency of less than 0.20 per cent in two ingredients. Only 13 brands were seriously short of guarantee. While 2 of these 13 brands showed a total deficiency of more than 0.20 per cent in two ingredients, in each case the shortage in one of the two was less than 0.20 per cent. There are therefore but 13 cases of serious shortage in 373 guarantees. In each case the deficiency appears due to imperfect mixing or to mechanical separation after mixing and a sufficient excess of other plant food is present to furnish a money equivalent.

It is safe to say, therefore, that *nine-tenths of the brands sold this year in Vermont furnished amounts of plant food equal to or more than what were guaranteed to be present and that all of the brands afforded the commercial equivalent of their guarantees.* This is a better showing than has been made in previous years as will be seen by the following table :

| Year | Number of brands analyzed | Number of brands above guarantee throughout | Number of brands seriously deficient | Per cent of total number essentially up to guarantee | Per cent of total number affording commercial equivalent of guarantee |
|---|---|---|---|---|---|
| 1895 | 92 | 60 | 16 | 83 | 95 |
| 1896 | 110 | 70 | 19 | 83 | 99 |
| 1897 | 134 | 86 | 21 | 84 | 94 |
| 1898 | 126 | 98 | 13 | 90 | 100 |

The 13 serious deficiencies of 1898 were distributed among the valuable ingredients as follows; nitrogen, 0; available phosphoric acid, 8; potash, 5.

The following table shows the number of brands sold by the different companies licensed in the state, the number of guarantees (nitrogen, available phosphoric acid, potash) made by each and the number of failures to make the same good (within 0.20 per cent) as judged by the analyses of the samples taken by the station :

MAINTENANCE OF GUARANTEES BY LICENSEES

| Name of company | Number of brands | Number of guarantees | Number of guarantees not made good |
|---|---|---|---|
| H. J. Baker & Bro | 9 | 27 | 1 |
| Bowker Fertilizer Co | 17 | 51 | 2 |
| Bradley Fertilizer Co | 13 | 39 | 1 |
| Clark's Cove Fertilizer Co | 3 | 9 | 0 |
| Cleveland Dryer Co | 7 | 21 | 0 |
| E. Frank Coe Co | 16 | 47 | 4 |
| Crocker Fert. and Chem. Co | 6 | 18 | 0 |
| Cumberland Bone Phosphate Co. | 4 | 12 | 0 |
| Great Eastern Fertilizer Co | 4 | 11 | 0 |
| Lister's Agri. Chem. Works | 6 | 17 | 0 |
| Lowell Fertilizer Co | 4 | 12 | 0 |
| Pacific Guano Co | 4 | 11 | 0 |
| Quinnipiac Co | 7 | 21 | 0 |
| Read Fertilizer Co | 8 | 23 | 0 |
| Russia Cement Co | 4 | 12 | 1 |
| Standard Fertilizer Co | 3 | 9 | 0 |
| Henry F. Tucker Co | 5 | 15 | 4 |
| Williams & Clark Fert. Co | 6 | 18 | 0 |
| Total | 126 | 373 | 13 |

The range of composition and the closeness with which guarantees are met are shown in the following table:

LOWEST, HIGHEST AND AVERAGE GUARANTEES, ANALYSES, SELLING PRICES AND VALUATIONS

| | Per cent guaranteed | | | Per cent found | | | Excess of average analysis over guarantee |
|---|---|---|---|---|---|---|---|
| | Lowest | Highest | Average | Lowest | Highest | Average | |
| Nitrogen | 0.41 | 8.25 | 2.02 | 0.73 | 8.35 | 2.21 | 0.19 |
| Total Phos. Acid | 5. | 14. | 9.39 | 5.58 | 15.73 | 10.91 | 1.52 |
| Avail. Phos. Acid | 4. | 12. | 7.90 | 4.44 | 12.11 | 8.83 | 0.93 |
| Potash | 1. | 10. | 3.52 | 1.93 | 10.73 | 3.81 | 0.29 |
| Selling price | $21. | $44. | $29.04 | | | | |
| Valuation | $8.75 | $30.45 | $16.44 | $9.88 | $31.78 | $17.86 | $1.42 |

For several years manufacturers have given as a rule but little more plant food than is shown by their minimum guarantee, which is exceeded on the average by but 10 per cent. Maximum guarantees are meaningless and misleading.

### GUARANTEES AND BRAND NAMES.

It is often difficult to say just what guarantees mean. The branding on the sacks may be illegible and the terms used are sometimes ill defined and the figures irrational. Many guarantees contain vast arrays of figures which are apt to confuse rather than to prove helpful. The buyer should ignore everything except the lower figures for nitrogen, (not ammonia or nitrogen equivalent to ammonia) available phosphoric acid and potash (not sulphate of potash or potash sulphate or potash equivalent to or equal to sulphate). In cases where ammonia (or nitrogen equivalent to ammonia) or sulphate of potash only are shown, their nitrogen and potash equivalents may be obtained by multiplying their respective guarantees by 0.823 and by 0.54.

Sometimes where both nitrogen and ammonia or both potash and sulphate of potash are stated, the minimum figures of each are discordant. Thus for example nitrogen, 3.5 per cent, ammonia, 4 per cent, is guaranteed in one brand, yet 4 per cent of ammonia is equivalent to but 3.29 per cent nitrogen. In another brand 2.5 per cent potash, and 5 per cent sulphate of potash are guaranteed, yet the latter figure is equivalent to 2.7 per cent potash. Many similar cases might be cited. The buyer would be on the safe side in assuming the lower figure as the true guarantee.

The names of the goods are often quite misleading, but no law does or can control the naming of a brand of fertilizer. Long ago the word "bone" ceased to mean that any bone was used, "guano" that the material was of natural origin, and "high-grade" that the goods were really such. "Corn manures" and "potato fertilizers" sometimes differ only in name. "A rose by any other name would smell as sweet," but calling a brand low in potash both corn and potato phosphate, neither augments its odor nor betters its service for the growth of the latter crop. It is generally true, moreover, that the lower the grade of the goods the more grandiloquent its title. It is far better to buy because of a suitable composition than because of an attractive name.

## AVAILABILITY OF ORGANIC NITROGEN.

Perhaps the most serious failure in analytical chemistry as applied to fertilizer inspection is the inability of the chemist surely to distinguish between readily available and comparatively inert forms of organic nitrogen. Considerable work has been done at this as well as at other stations with a view of perfecting laboratory methods of determining nitrogen availability. A statement of the present status of this line of work at this station will appear in the eleventh report. While methods are still too imperfect to warrant printing the figures obtained on each brand, yet suggestive results have been secured.

Two methods of determining nitrogen availability have been used this year, the pepsin digestion and the alkaline permanganate distillation methods. A modification of each has been employed, essentially equal weights of organic nitrogen (0.025 grams, [pepsin] and 0.045 grams, [permanganate], a percentage equivalent of 2.50 and 4.50 per cent on 1 gram of fertilizer), being digested or distilled in each case.

The pepsin method almost invariably gave higher figures than did the permanganate method, yet there was usually parallelism, goods running low in one showing also inferior results by the other process.

The following table groups the brands according to organic nitrogen availability as shown by the two methods:

COMPARISON OF METHODS

| Availability | | Alkaline permanganate | Pepsin digestion |
|---|---|---|---|
| Above 90 | per cent | 0 | 1 |
| 80 to 89 | " | 1 | 39 |
| 70 to 79 | " | 14 | 57 |
| 60 to 69 | " | 53 | 12 |
| 50 to 59 | " | 39 | 7 |
| 40 to 49 | " | 10 | 2 |
| Below 40 | " | 1 | 0 |
| | | 118* | 118 |

The point has often been made that there was greater likelihood of the use of inferior sources of organic nitrogen in low grade than in high grade goods. The following table contributes information on this point:

RELATION BETWEEN GRADE OF FERTILIZERS AND ORGANIC NITROGEN AVAILABILITY

| Selling price | Number of brands | Per cent of availability by permanganate | Per cent of availability by pepsin |
|---|---|---|---|
| $26.00 and below | 23 | 55.6 | 70.5 |
| 26.01— 27.99 | 30 | 61.7 | 74.5 |
| 28.00— 29.99 | 24 | 62.5 | 75.3 |
| 30.00— 32.49 | 13 | 59.1 | 76.5 |
| 32.50 and above | 26 | 61.4 | 77.7 |

The distinction is not marked by either method, yet the tendency is upwards as quality betters, low grades (selling below $28) averaging less availability by both methods than do medium or high grades.

The next table shows the organic nitrogen and total nitrogen availability of the average goods of each manufacturer, each brand analysed being given equal value in the average. Thus for example manufacturer A's goods are represented by 9 brands. The organic and the total nitrogen availabilities of each are added and the result divided by 9 to obtain the average. The results are ranged in the general order of their excellence. For reasons already stated the names of the firms are not given.

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*Of the 126 brands analyzed 5 contained no nitrogen and 3 contained practically all this element as nitrate.

### AVERAGE ORGANIC AND TOTAL NITROGEN AVAILABILITY

| | Per cent of availability by permanganate. | Per cent of availability by pepsin. | Per cent of total nitrogen available.[*] | | Per cent of availability by permanganate. | Per cent of availability by pepsin. | Per cent of total nitrogen available.[*] |
|---|---|---|---|---|---|---|---|
| 1 | 66 | 81 | 70 | 10 | 63 | 76 | 67 |
| 2 | 66 | 80 | 73 | 11 | 60 | 78 | 60 |
| 3 | 63 | 81 | 64 | 12 | 61 | 75 | 61 |
| 4 | 65 | 78 | 67 | 13 | 56 | 73 | 70 |
| 5 | 62 | 80 | 65 | 14 | 57 | 72 | 79 |
| 6 | 63 | 78 | 66 | 15 | 53 | 74 | 54 |
| 7 | 62 | 79 | 66 | 16 | 57 | 69 | 57 |
| 8 | 66 | 74 | 69 | 17 | 53 | 58 | 58 |
| 9 | 65 | 75 | 67 | 18 | 48 | 61 | 48 |

The quality of the organic nitrogen used by the manufacturers numbered 17 and 18 seems open to question if not, indeed, to suspicion. The original samples of the goods of these 2 companies, and a few other samples falling below 50 (permanganate) and 60 (pepsin), were tested with iron phosphate dissolved in glacial phosphoric acid[†] with a view of determining the presence or absence of leather. This is not a sure test; indeed no certain test is known. The coarser, more nitrogenous portion of each sample was sifted out and tested and the entire material was also used.

The results were negative. Inferior sources of organic nitrogen were probably present, but as far as the use of leather is concerned the verdict must be "not proven."

### SULPHATE OF POTASH.

The general claim, direct or inferential, found in guarantees, that sulphate of potash is used as a source of potash has proved this year, as in the past, to be as a rule misleading. In some cases, notably with the goods of one company, the claim is based on fact, high-grade sulphate being used. In most cases, however, low-grade sulphate, carrying considerable quantities of chlorin, or muriate (chlorid) is used. The absence of chlorids rather than the presence of sulphate is what is wanted in the fertilization of tobacco, sugar-beets and, sometimes, of potatoes.

The potash of 105 of the 126 brands analysed this year was guaranteed, directly or inferentially, to be derived from sulphate, a claim which was verified in but 19 cases, less than one-fifth of the entire number. Fourteen of the 18 licensed companies make general claims of using sulphate, but it rarely appears in the goods. Three companies neither claim nor use it.

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[*] Includes nitrogen from nitrates, ammonia salts and organic nitrogen available by permanganate.

[†] Dabney, Bul. N. C. Exp. Sta. 3 (1885); Lindsey, Rpt. Mass. (State) Exp. Sta., 12 (1894), pp. 300-301.

### AVERAGE GRADES SOLD IN THE NORTH-EASTERN STATES.

Is the average grade of the goods sold in Vermont better or poorer than that offered in neighboring states? Does plant food in mixed fertilizers cost more than in the seaboard New England and the Middle States? Reference to the reports and bulletins of the stations of the several states furnishes the following table:

AVERAGE COMPOSITION OF COMMERCIAL FERTILIZERS—INSPECTION OF 1897

| State | Number of brands | Nitrogen | Total Phos. Acid | Available Phos. Acid | Insoluble Phos. Acid | Potash | Selling price | Station valuation | Value plant food bought for a dollar cents |
|---|---|---|---|---|---|---|---|---|---|
| Maine | 134 | 2.11 | 10.96 | 8.65 | 2.31 | 3.93 | ...... | $19.60 | ...... |
| New Hampshire | 112 | 2.20 | 11.17 | 8.52 | 2.65 | 4.14 | ...... | 20.03 | ...... |
| Vermont | 134 | 2.12 | 11.25 | 9.02 | 2.23 | 3.43 | $29.19 | 19.47 | 67 |
| Massachusetts | 198 | 2.85 | 10.95 | 8.04 | 2.91 | 4.85 | ...... | 22.09 | ...... |
| Rhode Island | 138 | 2.86 | 10.80 | 8.50 | 2.30 | 4.86 | ...... | 22.37 | ...... |
| Connecticut | 197 | 2.83 | 10.64 | 8.41 | 2.23 | 5.17 | 32.51 | 22.57 | 69 |
| New York | 572 | 2.07 | 10.74 | 8.67 | 2.07 | 4.37 | 27.70 | 19.75 | 71 |
| New Jersey | 285 | 2.54 | 10.93 | 8.01 | 2.92 | 5.01 | 29.28 | 21.58 | 74 |

The analyses of mixed goods only have entered into the above table. Selling prices are not stated in the Maine, New Hampshire, Massachusetts and Rhode Island bulletins.

The average grade of goods offered in the northern tier of states is distinctly lower than that sold in the states lying to the south. The differences in nitrogen and potash are decided and clear cut, in available phosphoric acid less so. The distinction is best brought out in the following table, showing the highest and lowest average per cent of each ingredient in each group:

| | Me., N. H., Vt., N. Y. | Mass., R. I., Conn., N. J. |
|---|---|---|
| Nitrogen | 2.07— 2.20 | 2.54— 2.86 |
| Available Phosphoric Acid | 9.02— 8.52 | 8.50— 8.01 |
| Potash | 3.43— 4.37 | 4.85— 5.17 |
| Station valuations | $19.47—20.03 | $21.58—22.57 |

It would appear that the average grade sold in Vermont is as low as any and lower than in most of the eight states. Also, as far as the fragmentary data at hand permit deductions, that plant food in mixed goods is at least as costly as in any other state and more expensive than in most states. The reasons for this condition are not difficult to find. They apply in a measure likewise to the trade in the states of Maine and New Hampshire.

1. Dairying is more prominent in northern than in southern New England, while market-gardening, tobacco raising, etc., are relatively more important in the latter locality. Dairying tends to enlarge the store of plant food in the soil, nitrogen in particular being increased; market-gardening, etc., depletes it.

2. Truck crops call largely for readily available nitrogen and potash; natural fertilizers are relatively slow, and commercial fertilizers quick in their action.

3. Freight rates favor southern New England.

4. The larger and longer use of commercial fertilizers by the farmers of southern New England and New Jersey has taught them that in the absence of barn yard manure a relatively high grade of goods is preferable.

5. The experiment stations, notably of Connecticut and New Jersey, have been preaching the doctrine of high grade goods for a score of years.

### 2. THE RELATION BETWEEN SELLING PRICES AND STATION VALUATIONS.

The necessity of a careful study of the relation of the selling prices of the various brands of commercial fertilizers to the money values of the plant food they contain has been repeatedly urged in the publications of this station. The wisdom of this course is again asserted and will probably be reiterated in the future. This emphasis, however, should not lead the buyer to underrate the more important yet less easily stated agricultural value of commercial fertilizers. The adaptation of the goods to the particular soil, and crop on which it is to be used and its value as a supplement to home manurial supplies should be paramount and commercial considerations secondary. The station analyses are directly helpful in aiding the intelligent buyer in the selection of goods best fitted to meet his needs. Valuations, however, are not of use in this connection; indeed, in so far as they tend to distract the buyer's attention from the main to the subordinate phase of the problem, they are distinctly harmful and fail in their mission. They are not, however, without good reason for existence and serve as no other means can as measures of commercial worth, and as a common basis on which commercially to compare various brands. They indicate whether selling prices are justified by intrinsic commercial values, and indirectly serve in the more certain exposure of fraudulent goods.

The multiplicity of brands and the ubiquity of the fertilizer agent afford a wide choice in all parts of the state. As a rule, moreover, the buyer of mixed goods can feel a fair degree of confidence in the quality of the raw material used by well established and reputable firms. Such being the case it is the part of wisdom to select from brands at hand and suitable to individual needs, that one which affords the most plant food for the dollar of cost in other words to study the relation of selling prices to the commercial value. An example may serve to make this point more clear. The following brands, all having been considered suitable to the needs of the buyer, in view of analyses, crop and soil needs, supply of manure in hand, etc., etc., the question arises which offers the most for the money :

| | Nitrogen | Phosphoric Acid<br>Soluble | Phosphoric Acid<br>Reverted | Phosphoric Acid<br>Insoluble | Potash | Selling price | Station valuation | Ratio of price to valuation |
|---|---|---|---|---|---|---|---|---|
| A. | 2.5 | 7. | 2 | 1 | 4.25 | $30 | $18.91 | 1: .63 |
| B. | 2.25 | 7.5 | 2 | 1 | 3.5 | 30 | 18.13 | 1: .60 |
| C. | 2. | 6. | 2 | 1 | 4.5 | 29 | 16.83 | 1: .58 |
| D. | 2.3 | 6.5 | 2 | 1 | 3.5 | 30 | 18.27 | 1: .61 |

In brand A is offered 63 cents worth of plant food for a dollar as against 60, 58 and 61 cents worth in the other brands. The chances are that it would prove at least as satisfactory as any of the other brands and probably should be chosen.

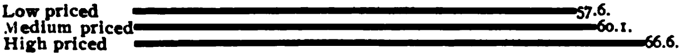
The relation of selling price to valuation in the goods of different grades is an important matter. Separating 123* brands according to selling prices we obtain the following figures :

RELATION OF SELLING PRICES AND VALUATIONS OF THE AVERAGES, HIGHEST AND LOWEST OF DIFFERENT GRADES OF FERTILIZERS

| Selling price | Number of brands in group | Cents worth of plant food at retail seaboard prices bought for a dollar at consumer's depot | | | Number of brands in group which for a dollar furnish— | |
|---|---|---|---|---|---|---|
| | | Highest | Lowest | Average | 55 cents or less worth of plant food | 65 cents or more worth of plant food |
| $26 and below | 29 | 65 | 39 | 54.1 | 18 | 2 |
| 26.01–27.99 | 30 | 70 | 53 | 61.2 | 3 | 8 |
| 28–29.99 | 24 | 68 | 49 | 60.7 | 4 | 5 |
| 30–32.49 | 13 | 73 | 49 | 59.5 | 2 | 2 |
| 32.50 and above | 27 | 79 | 58 | 66.6 | 0 | 19 |

The reduction in the "trade values" of available phosphoric acid for the present year and the essential uniformity of selling prices in 1897 and 1898 result in lowering the purchasing value of a dollar as compared with previous years.

The comparison can be shown graphically. The relative lengths of the following lines show the average money value in plant food at retail seaboard prices bought for a dollar at Vermont delivery points in brands selling for less than $28 (low priced), from $28 to $32 (medium priced), and for $32.50 and above (high priced):



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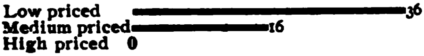
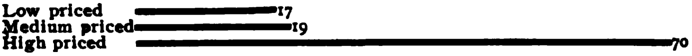
*Three brands are not included. Two were sampled after the table was made and one is a lawndressing, milled extra fine and sold in small quantities only at relatively high prices.

The following lines show the per cent of the total number of brands in each group containing 55 cents or less worth of plant food for each dollar invested:



The final set of lines shows the per cent of the total number of brands in each group containing 65 cents or more worth of plant food for each dollar invested:



If lines and figures are put into words, it will be seen that:

(1) *A dollar spent for average low priced brands (below $28) bought 58 cents worth of plant food at retail seaboard prices; a dollar invested in average medium grade goods ($28 to $32), 60 cents worth; and a dollar paid out for average high class goods ($32.50 and upwards), 67 cents worth.* A dollar bought 79 cents worth of plant food in one brand sold in the state this year, while it purchased but 39 cents worth in another brand. It is interesting to note that the brands giving 79 and 39 cents worth of plant food for a dollar, likewise ranked first and last among 134 brands last year, measured by the same standard. *One-fifth* of the entire number of brands furnished less than 55 cents worth of plant food to the dollar.

(2) *Thirty-six per cent of the total number of low priced goods contain plant food worth 55 cents or less for each dollar of cost,* while but *16 per cent* of the total number of medium grade and *none* of the high grade brands contain as little relative commercial value as this.

(3) *Seventy per cent of the total number of high class goods contain plant food worth 65 cents or more for each dollar of cost,* while but 19 per cent of the total number of medium grade and 17 per cent of the total number of low priced brands contained as much relative commercial value as this.

### LOW GRADE GOODS.

The tendency of the trade in Vermont is more and more decidedly toward the larger purchase of low grade goods. The number of brands having nitrogen guarantees below 1.25 per cent found in the inspections of the last four years, have been 30, 33, 43 and 45 respectively, or 33, 30, 32 and 36 per cent of the entire number sold. These figures furnish no clue to amounts used, but, judging by the statements of general agents and by the amounts of the various grades found by the station sampling agents, large quantities of low grade fertilizers are sold.

There seem to be two main reasons for this trend of trade, one of which is good, the other bad.

1. The percentage of nitrogen more than that of either of the other two ingredients determines the grade of the goods. Barnyard manure, largely made on dairy farms, is relatively rich in nitrogen, thus obviating the necessity of the purchase of that ingredient in large quantities.

2. Quantity rather than quality, the most weight rather than the most plant food often determines choice. Ill-considered, haphazard purchase, guided by agents' claims, highsounding names and apparent cheapness, is far too frequent.

Low grade goods cost relatively high prices, because the cost of manufacture and sale are proportionately greater than those of medium or of high class. It costs as much to mix, bag, freight and sell inert material as similarly to handle plant food. One brand, sold this year at $23, offered but 176 pounds of plant food, while another, sold at $37, guaranteed 454 pounds. Sixty per cent more money bought 160 per cent more plant food. The one was claimed to contain but $8.75 worth of plant food while the other promised $25.34 worth, nearly thrice as much. The manufacturers of the low grade brand asked 62 cents for mixing, bagging, freighting, and selling 38 cents worth of plant food, while those who offered the higher priced fertilizer asked only half as much, 31 cents, for handling nearly twice as much value in plant food, 68 cents worth.

There is moreover greater likelihood of inferior raw materials being used in the cheap than in the higher grades. The latter can be made only from the better classes of crude stock, which, if used in low grade goods, must of necessity be mixed with considerable quantities of inert material or "filler." Low priced brands offer the main outlet for certain kinds of raw materials which, because of their poor quality could not be used in high class fertilizers.

The inference should not be drawn that all low priced goods are expensive and all high cost brands really cheap. There are extremes in each class. While in general it is true that the best are the cheapest, yet some low grade brands, provided they are made from good raw materials are not over expensive at the price asked, while some high priced fertilizers cost too much in proportion to the money value of the plant food they contain. Fifteen brands out of the 83 which cost less than $30 supply 65 cents or more worth of fertility for a dollar. There were two brands out of the 40 costing $30 or more which furnished less than 55 cents worth of plant food for a dollar. In one of these latter cases but 49 cents worth was given for a dollar, yet the same goods, shovelled from the same pile, containing the same ingredients, and bearing the same guarantee were sold under another and less fanciful name for from four to five dollars less and furnished 57 cents worth of plant food to the dollar.

Brands low in nitrogen may frequently prove agriculturally successful if carefully selected, with a view of getting as large a money value as possible, and used in connection with barn yard manure, or on land already rich in nitrogen. The well informed buyer, however, will not infrequently decide either to buy crude stock directly or else to get smaller quantities of higher grades.

### THE "BEST FERTILIZER."

The station officers are often asked "what is the best fertilizer" or "are Smith's fertilizers as good as Jones'." The obvious answer to the latter query is that Smith makes 20 and Jones 25 brands, that Smith's high class goods are usually cheaper at the price and will quite generally prove more satisfactory than Jones' low grade brands and vice versa.

As regards the first question, however, no one can safely say for another that any one fertilizer is the best for him to use. It is usually safe to buy of firms of known reputation, to observe the results reported on similar crops and soils by reliable farmers, to consider carefully home resources, and finally, if the purchase of raw materials and home mixing seem inadvisable, to select such brands as offer the most plant food for the money invested, provided the composition of the goods fits one's special needs.

Such a choice would be usually the "best." What it is no one can tell better than the intelligent buyer. Measured by this standard there may be a score or more "best" fertilizers sold in the state to-day.

## III. LICENSED FERTILIZERS SAMPLED BY STATION.*

### H. J. Baker & Co., New York, N. Y.

6058. **Cabbage Manure**; from stock of Geo. Hinsdill, North Bennington.

6058. **Complete Manure for General Use**; from stock of Geo. Hinsdill, North Bennington.

6057. **Complete Grass Manure**; from stock of Geo. Hinsdill, North Bennington.

6055. **Complete Nitrogenized Manure**; from stock of Geo. Hinsdill, North Bennington.

6059. **Complete Onion Manure**; from stock of Geo. Hinsdill, North Bennington.

6052. **Complete Potato and Vegetable Manure**; from stock of B. T. Hewey, North Bennington.

6128. **Standard UNXLD Fertilizer**; from stocks of B. T. Hewey, North Bennington; Burritt Bros., Manchester.

### Bowker Fertilizer Co., Boston, Mass.

6122. **Bone and Wood Ash**; from stock of A. L. Aseltine, Swanton.

5981. **Market Garden Fertilizer**; from stock of L. F. Fortney, Plainfield.

5815. **Potash Bone**; from stock of K. T. Brown, Lunenburgh.

6035. **Stockbridge Manure for Seeding Down**; from stock of C. E. Perry, Newfane.

5978. **Stockbridge Manure for Strawberries**; from stock of Harry Kelley, Bradford.

5942. **Stockbridge Manure for Vegetables and Potatoes**; from stock of W. E. Granger, Williamstown.

5966. **Vermont Grange Chemicals, D. Brand**; from stock of A. E. Fuller, Woodstock.

### Bradley Fertilizer Co., Boston, Mass.

6123. **B. D. Sea Fowl Guano**; from stock of Maynard and Marsh, Sheldon.

6131. **Complete Manure for Potatoes and Vegetables**; from stock of E. A. Morse, Calais.

5682. **Complete Manure with 10 per cent Potash**; from stock of N. Spooner, Randolph.

6121. **English Lawn Dressing**; from stock of A. G. Pierce, Burlington.

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* The names and locations of agents from whom samples were taken, which made analytical samples reported in Bulletins 63 and 64 and reprinted in this bulletin, may be found on reference thereto.

**5955. Potato Manure**; from stock of E. B. Arbuckle, East Montpelier.

**6016. Seeding Down Fertilizer**; from stock of L. W. Loukes, Vergennes.

### Cleveland Dryer Co., Boston, Mass.

**5638. High Grade Complete Manure**; from stock of M. A. Nelson, Montpelier.

**5640. Pioneer Fertilizer**; from stock of M. A. Nelson, Montpelier.

**5964. Seeding Down Fertilizer**; from stock of S. S. Brooks, Royalton.

**6124. Superphosphate**; from stocks of D. Spooner, Randolph; F. B. Gillette, Jonesville.

### E. Frank Coe Co., New York, N. Y.

**6020. Celebrated Special Potato Fertilizer**; from stock of R. T. Ketchum, Sudbury.

**5883. Columbian Ammoniated Bone Superphosphate**; from stock of Lorimer & MacDiarmid, Newport.

**6129. Excelsior Potato Fertilizer**; from stock of L. F. Shonyo & Son, Lyndonville.

**6130. Ground Bone and Potash**; from stock of L. F. Shonyo & Son, Lyndonville.

**6125. New England Special for Corn**; from stocks of R. T. Ketchum, Sudbury; Norton Hardware Co., Fair Haven.

**6126. New England Special for Potatoes**; from stocks of J. B. Freeman, Barton; Norton Hardware Co., Fair Haven.

**6032. Original New England Brand Tobacco Fertilizer**; from stock of G. A. Littlefield, Putney.

**5962. Red Brand Excelsior Guano**; from stock of Adams & Alexander, Randolph Centre.

**5759. Seeding Down and Top Dressing Fertilizer**; from stock of E. B. Rising, Brandon.

**6116. Standard Grade Ammoniated Bone Superphosphate**; from stock of Jordan Bro., Jericho Centre.

### Crocker Fertilizer & Chemical Co., Buffalo, N. Y.

**5990. Special Potato Manure**; from stock of A. R. Wells, Newport.

### Lister's Agricultural Chemical Works, Newark, N. J.

**6041. Potato Manure**; from stock of J. Doe, Brattleboro.

### Pacific Guano Co., Boston, Mass.

**5865. Dissolved Bone and Potash**; from stock of C. W. Coffran, Lyndonville.

### Quinnipiac Co., Boston, Mass.

**5743. Phosphate**; from stock of Mellen & Proctor, Brattleboro.

### Russia Cement Co., Gloucester, Mass.

**5976. High Grade Superphosphate**; from stock of R. C. Martin, Bradford.

### Standard Fertilizer Co., Boston, Mass.

**5826. Guano for all Crops**; from stock of H. M. Knapp, East St. Johnsbury.

### Henry F. Tucker Co., Boston, Mass.

**6127. Imperial Bone Superphosphate for all Crops**; from stocks of G. D. Kidder, Plainfield; F. B. Gillett, Jonesville.

**5952. Original Bay State Bone Superphosphate**; from stock of C. F. Wheeler, Worcester.

### Williams & Clark Fertilizer Co., New York, N. Y.

**5732. High Grade Special for Potatoes, Onions, Tobacco, Cabbage and Cauliflower**; from stock of Gilman Robinson, Woodstock.

### EXPLANATION OF TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers upon the next 11 pages show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 81 of this bulletin, and presumably soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicised* type gives *guarantees*, the **black-faced** type gives the **most important figures found by analysis.**

## IV. ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| 6058 | Baker's Cabbage Manure | 0.75 | 2.31 | 1.76 | **4.82** | *4.75* | $13.35 | 5.29 | 1.58 | 0.44 | **7.31** | *6.* | **6.87** | *5.* | $ 6.20 | **7.67** | *7.* | $6.52 | 6058 |
| 6056 | Baker's Complete for General Use | 0.24 | 1.14 | 1.34 | **2.72** | *2.47* | 7.57 | 7.46 | 1.65 | 0.52 | **9.63** | *9.* | **9.11** | *8.* | 8.24 | **6.54** | *6.* | 5.56 | 6056 |
| 6057 | Baker's Complete Grass Manure | 0.94 | 1.41 | 1.37 | **3.72** | *3.7* | 10.23 | 4.65 | 1.58 | 0.38 | **6.61** | *6.* | **6.23** | *5.* | 5.60 | **8.75** | *7.5* | 7.44 | 6057 |
| ¶6055 | Baker's Complete Nitrogenized | 0.62 | 2.53 | 5.20 | **8.35** | *8.25* | 23.26 | 3.93 | 1.55 | 1.64 | **7.12** | *6.* | **5.48** | *5.* | 5.43 | **3.52** | *3.* | 3.09 | 6055 |
| 6059 | Baker's Complete Onion Manure | 0.59 | 2.43 | 1.80 | **4.82** | *4.94* | 13.38 | 5.30 | 1.30 | 0.52 | **7.12** | *5.5* | **6.60** | *4.5* | 6.02 | **7.75** | *9.* | 6.59 | 6059 |
| 6052 | Baker's Complete Pot. & Veg. Manure | ...... | 0.90 | 1.89 | **2.79** | *2.47* | 7.81 | 5.34 | 2.14 | 1.04 | **8.52** | *7.* | **7.48** | *6.* | 6.93 | **4.87** | *5.* | 4.14 | 6052 |
| ‡¶6054 | Baker's Complete Potato Manure | 0.77 | 1.74 | 1.05 | **3.56** | *3.3* | 9.82 | 5.15 | 2.00 | 1.14 | **8.29** | *6.75* | **7.15** | *5.75* | 6.68 | **10.35** | *10.* | 9.40 | 6054 |
| ‡6051 | Baker's Harvest Home Fertilizer | ...... | 0.32 | 1.02 | **1.34** | *1.08* | 3.75 | 5.10 | 4.01 | 1.99 | **11.10** | *9.* | **9.11** | *8.* | 8.60 | **3.07** | *2.* | 2.61 | 6051 |
| 6128 | Baker's Standard UnXLD Fertilizer | 0.36 | 0.76 | 1.05 | **2.15** | *1.85* | 6.00 | 4.94 | 4.29 | 1.91 | **11.14** | *9.* | **9.23** | *8.* | 8.64 | **2.81** | *2.25* | 2.39 | 6128 |
| §6122 | Bowker's Bone and Wood Ash | 1.59 | ...... | 0.26 | **1.82** | *1.64* | 4.86 | 0.05 | 7.82 | 4.00 | **11.87** | *8.* | **7.87** | *6.* | 7.90 | **2.66** | *2.* | 2.66 | 6122 |
| ‡5921 | Bowker's Corn Phosphate | 0.42 | ...... | 1.51 | **1.93** | *1.5* | 5.32 | 5.25 | 3.22 | 2.07 | **10.54** | *11.* | **8.47** | *9.* | 8.13 | **2.34** | *2.* | 1.98 | 5921 |
| ‡6077 | Bowker's Farm and Garden Phos. | 0.51 | ...... | 1.30 | **1.81** | *1.6* | 4.97 | 5.52 | 3.16 | 2.84 | **11.52** | *10.* | **8.68** | *8.* | 8.63 | **2.44** | *2.* | 2.07 | 6077 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52 of Bulletin 63. ‡ Reprinted from Bulletin 64.

§Potash probably mainly as carbonate. ¶Potash partly as sulphate.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| ‡6076 | Bowker's Hill and Drill Phosphate.. | 0.64 | ...... | 2.05 | **2.69** | *2.25* | 7.40 | 6.81 | 3.05 | 2.27 | **12.13** | *12.* | **9.86** | *9.* | 9.48 | **2.47** | *2.* | 2.10 | 6076 |
| 5981 | Bowker's Market Garden Fertilizer.. | 1.14 | ...... | 1.43 | **2.57** | *2.47* | 6.97 | 3.09 | 3.19 | 4.25 | **10.53** | *8.* | **6.28** | *6.* | 7.04 | **10.73** | *10.* | 9.12 | 5981 |
| 5815 | Bowker's Potash Bone.................... | ...... | ...... | 0.93 | **0.93** | *0.75* | 2.60 | 2.05 | 2.97 | 2.88 | **7.90** | *7.* | **5.02** | *5.* | 5.37 | **2.25** | *2.* | 1.91 | 5815 |
| ‡6061 | Bowker's Potash or Staple Phosphate | 0.23 | ...... | 0.86 | **1.09** | *0.75* | 3.01 | 2.64 | 5.46 | 2.94 | **11.04** | *10.* | **8.10** | *8.* | 7.92 | **3.35** | *3.* | 2.85 | 6061 |
| ‡6060 | Bowker's Potato and Veg. Phos...... | 0.42 | ...... | 1.45 | **1.87** | *1.5* | 5.15 | 5.37 | 3.29 | 1.90 | **10.56** | *10.* | **8.66** | *8.* | 8.22 | **2.27** | *2.* | 1.93 | 6060 |
| ‡6062 | Bowker's Stockbridge Corn Manure | 1.43 | ...... | 2.07 | **3.50** | *3.* | 9.52 | 5.85 | 3.26 | 2.12 | **11.23** | *10.* | **9.11** | *8.* | 8.72 | **7.54** | *6.* | 6.41 | 6062 |
| ‡5920 | Bowker's Stockbridge Potato Man... | 1.21 | ...... | 2.27 | **3.48** | *3.2* | 9.51 | 5.15 | 2.44 | 1.66 | **9.25** | *7.* | **7.59** | *5.* | 7.25 | **10.26** | *10.* | 8.72 | 5920 |
| 6035 | Bowker's Stockbridge Seeding Down | 0.63 | ...... | 1.97 | **2.60** | *2.25* | 7.15 | 2.56 | 4.17 | 4.55 | **11.28** | ....... | **6.73** | *6.* | 7.46 | **9.61** | *10.* | 8.17 | 6035 |
| *5978 | Bowker's Stockbridge Strawberries.. | 0.57 | ...... | 2.15 | **2.72** | *2.47* | 7.52 | 7.48 | 2.96 | 2.29 | **12.73** | *7.* | **10.44** | *6.* | 10.02 | **4.13** | *4.* | 4.10 | 5978 |
| ‡6106 | Bowker's Stockbridge Top Dr's'g M. | 2.83 | ...... | 2.18 | **5.01** | *4.75* | 13.46 | 4.49 | 2.23 | 2.05 | **8.77** | *6.* | **6.72** | *4.* | 6.64 | **6.63** | *6.* | 5.64 | 6106 |
| 5942 | Bowker's Stockbridge Vegetable...... | 1.18 | ...... | 2.18 | **3.36** | *3.5* | 9.17 | 5.80 | 2.70 | 2.36 | **10.86** | *8.* | **8.50** | *6.* | 8.32 | **7.28** | *7.* | 6.19 | 5942 |
| ‡6078 | Bowker's Sure Crop Phosphate........ | 0.19 | ...... | 0.80 | **0.99** | *0.75* | 2.73 | 6.46 | 4.04 | 2.77 | **13.27** | *10.* | **10.50** | *8.* | 10.15 | **1.19** | *1.* | 1.01 | 6078 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50-52 of Bulletin 63. ‡Reprinted from Bulletin 64.

# ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| 5966 | Bowker's Vt. Grange Chem. D Brand | 0.60 | ...... | 2.07 | **2.67** | *2.06* | $ 7.37 | 5.26 | 3.29 | 2.31 | 10.86 | *9.* | 8.55 | *8.* | $8.29 | **4.44** | *3.* | $3.77 | 5966 |
| ‡5919 | Bowker's Vermont Phosphate......... | 0.96 | ...... | 1.60 | **2.56** | *1.75* | 6.98 | 6.63 | 2.78 | 1.28 | 10.69 | *10.* | 9.41 | *8.* | 8.70 | **4.58** | *3.* | 3.89 | 5919 |
| 6123 | Bradley's B. D. Sea Fowl Guano...... | ...... | ...... | 2.16 | **2.16** | *2.05* | 6.05 | 3.48 | 5.22 | 2.71 | 11.41 | *10.* | 8.70 | *8.* | 8.39 | **1.71** | *1.5* | 1.45 | 6123 |
| 6131 | Bradley's Complete Potato & Veg..... | 0.73 | 0.44 | 1.99 | **3.16** | *3.3* | 8.70 | 5.25 | 3.79 | 1.65 | 10.69 | *9.* | 9.04 | *8.* | 8.42 | **7.27** | *7.* | 6.18 | 6131 |
| 5682 | Bradley's Complete 10% Potash......... | 0.40 | 0.51 | 2.40 | **3.31** | *3.3* | 9.23 | 4.25 | 3.65 | 1.86 | 9.76 | *7.* | 7.90 | *6.* | 7.49 | **9.39** | *10.* | 7.98 | 5682 |
| ‡6063 | Bradley's Complete Top Dressing..... | 4.96 | ...... | 0.12 | **5.08** | *4.95* | 13.24 | 3.52 | 3.60 | 0.86 | 7.98 | *6.* | 7.12 | *5.* | 6.39 | **2.85** | *2.5* | 2.78 | 6063 |
| ‡5910 | Bradley's Corn Phosphate......... ..... | ...... | ...... | 2.07 | **2.07** | *2.06* | 5.80 | 5.67 | 4.09 | 2.82 | 12.58 | *10.* | 9.76 | *9.* | 9.50 | **1.74** | *1.5* | 1.48 | 5910 |
| ‡5912 | Bradley's Eclipse Phosphate ........... | ...... | ...... | 1.67 | **1.67** | *1.* | 4.68 | 5.30 | 5.18 | 2.60 | 13.08 | *12.* | 10.48 | *10.* | 9.95 | **1.78** | *1.5* | 1.51 | 5912 |
| *6121 | Bradley's English Lawn Dressing.... | 4.91 | ...... | 0.09 | **5.00** | *4.95* | 13.02 | 2.43 | 3.71 | 1.62 | 7.76 | *6.* | 6.14 | *5.* | 5.80 | **2.91** | *2.5* | 2.86 | 6121 |
| ‡6081 | Bradley's Patent Superphosphate..... | ...... | ...... | 2.52 | **2.52** | *2.05* | 7.06 | 6.68 | 3.43 | 1.98 | 12.09 | *11.* | 10.11 | *9.* | 9.55 | **2.16** | *2.* | 1.84 | 6081 |
| ‡5911 | Bradley's Potato Fertilizer............. | ...... | ...... | 2.18 | **2.18** | *2.06* | 6.10 | 5.99 | 3.08 | 2.49 | 11.56 | *11.* | 9.07 | *9.* | 8.85 | **3.49** | *3.25* | 2.97 | 5911 |
| 5955 | Bradley's Potato Manure................. | 0.37 | ...... | 2.32 | **2.69** | *2.5* | 7.46 | 3.55 | 2.55 | 3.14 | 9.24 | *8.* | 6.10 | *6.* | 6.49 | **5.23** | *5.* | 4.45 | 5955 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52 of Bulletin 63. ‡ Reprinted from Bulletin 64.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| 6016 | Bradley's Seeding Down Fertilizer... | ...... | ...... | 1.76 | **1.76** | *1.65* | $ 4.93 | 6.31 | 2.49 | 2.43 | **11.23** | *10.* | **8.80** | *5.* | $ 8.64 | **1.30** | *1.06* | 1.11 | 6016 |
| ‡6064 | Bradley's Vermonter for All Crops .. | ...... | ...... | 2.11 | **2 11** | *2.06* | 5.91 | 6.80 | 2.97 | 1.65 | **11.42** | *10.* | **9.79** | *8.* | 9.16 | **4.60** | *3.5* | $3.91 | 6064 |
| ‡5909 | Bradley's XL Superphosphate......... | ...... | ...... | 2.52 | **2.52** | *2.5* | 7.06 | 6.72 | 3.78 | 1.85 | **12 35** | *11.* | **10.50** | *9.* | 9.81 | **2.08** | *2.* | 1.77 | 5909 |
| ‡5937 | Clark's Cove Bay State Fert. G. G... | ...... | ...... | 2.15 | **2.15** | *1.85* | 6.02 | 5.34 | 3.87 | 2.51 | **11.72** | *10.* | **9.21** | *8.5* | 8.91 | **2.37** | *2.* | 2.01 | 5937 |
| ‡6088 | Clark's Cove King Philip Alk. Gua.. | ...... | ...... | 1.20 | **1.20** | *1.03* | 3.36 | 5.85 | 2.82 | 1.91 | **10.58** | *9.* | **8.67** | *8.* | 8.28 | **2.36** | *2.* | 2.01 | 6088 |
| ‡6087 | Clark's Cove Potato Fertilizer......... | ...... | ...... | 2.11 | **2.11** | *2.06* | 5.91 | 4.68 | 3.84 | 3.10 | **11.62** | *9.* | **8.52** | *8.* | 8.53 | **2.96** | *3.* | 2.51 | 6087 |
| ‡5913 | Cleveland Corn and Grain Phos...... | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.41 | 3.97 | 3.01 | **12.39** | *10.5* | **9.38** | *9.5* | 9.25 | **1.60** | *1.5* | 1.36 | 5913 |
| ‡6067 | Cleveland Fertilizer for All Crops ... | ...... | ...... | 1.16 | **1.16** | *1.03* | 3.25 | 5.94 | 2.51 | 1.76 | **10.21** | *9.* | **8.45** | *8.* | 8.06 | **2.33** | *2.* | 1.98 | 6067 |
| 5638 | Cleveland High Grade Complete...... | 0.72 | 0.49 | 2.11 | **3.32** | *3.3* | 9.15 | 5.29 | 3.33 | 2.42 | **11.04** | *9.* | **8.62** | *8.* | 8.39 | **7.29** | *7.* | 6.20 | 5638 |
| 5640 | Cleveland Pioneer Fertilizer............ | ...... | ...... | 1.16 | **1.16** | *0.82* | 3.25 | 4.92 | 3.30 | 2.28 | **10.50** | *9.* | **8.22** | *7.* | 7.98 | **1.48** | *1.* | 1.26 | 5640 |
| ‡5914 | Cleveland Potato Phosphate............ | ...... | ...... | 2.11 | **2.11** | *2.06* | 5.91 | 5.63 | 3.24 | 3.02 | **11.89** | *10.* | **8.87** | *8.* | 8.87 | **3.30** | *3.* | 2.81 | 5914 |
| 5964 | Cleveland Seeding Down Fertilizer... | ...... | ...... | 1.11 | **1.11** | *1.03* | 3.11 | 5.81 | 3.16 | 2.04 | **11.01** | *9.* | **8.97** | *8.* | 8.57 | **2.33** | *2.* | 1.98 | 5964 |

* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52 of Bulletin 63. ‡Reprinted from Bulletin 64.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| 6124 | Cleveland Superphosphate | ...... | ...... | 1.99 | **1.99** | *2.05* | $5.57 | 4.94 | 4.25 | 3.06 | **12.25** | *11.* | **9.19** | *9.* | $9.07 | **2.15** | *2.* | $1.83 | 6124 |
| *6091 | Coe's Cel. Spec. Grass and Grain | ...... | ...... | 1.13 | **1.13** | *0.83* | 3.16 | 7.52 | 3.63 | 2.35 | **13.50** | *10.* | **11.15** | *9.* | 10.61 | **1.81** | *1.35* | 1.76 | 6091 |
| *6020 | Coe's Cel. Spec. Potato Fertilizer | ...... | 0.33 | 1.61 | **1.94** | *1.65* | 5.43 | 6.38 | 3.15 | 1.99 | **11.52** | *10.* | **9.53** | *8.* | 9.06 | **3.77** | *4.* | 3.72 | 6020 |
| *5883 | Coe's Columbian Ammo. Bone | ...... | 0.18 | 1.37 | **1.55** | *1.23* | 4.34 | 7.61 | 3.08 | 2.84 | **13.53** | *11.* | **10.69** | *9.* | 10.45 | **2.16** | *1.85* | 2.16 | 5883 |
| *‡5917 | Coe's Columbian Corn Fertilizer | ...... | ...... | 1.51 | **1.51** | *1.23* | 4.23 | 7.46 | 3.37 | 2.37 | **13.20** | *11.* | **10.83** | *9.* | 10.36 | **2.06** | *1.85* | 2.06 | 5917 |
| *‡5918 | Coe's Columbian Potato Fertilizer | ...... | ...... | 1.53 | **1.53** | *1.23* | 4.28 | 7.48 | 3.16 | 2.42 | **13.06** | *11.* | **10.64** | *9.* | 10.23 | **1.98** | *1.85* | 1.98 | 5918 |
| *6129 | Coe's Excelsior Potato Fertilizer | ...... | 0.77 | 2.00 | **2.77** | *2.5* | 7.77 | 5.89 | 1.78 | 1.55 | **9.22** | *9.* | **7.67** | *8.* | 7.34 | **8.16** | *8.* | 8.04 | 6129 |
| 6130 | Coe's Ground Bone and Potash | ...... | ...... | 2.04 | **2.04** | *2.* | 5.71 | 0.06 | 10.41 | 5.26 | **15.73** | *12.8* | **10.47** | ...... | 10.49 | **2.78** | *2.5* | 2.36 | 6130 |
| ‡*6100 | Coe's H. G. Ammo. Bone Superphos. | ...... | 0.22 | 1.97 | **2.19** | *2.06* | 6.13 | 6.94 | 3.22 | 1.78 | **11.94** | *11.* | **10.16** | *9.* | 9.54 | **2.30** | *1.85* | 2.30 | 6100 |
| *6125 | Coe's N. E. Special for Corn | ...... | ...... | 1.17 | **1.17** | *0.82* | 3.28 | 6.61 | 3.80 | 3.12 | **13.53** | *11.* | **10.41** | *9.* | 10.24 | **2.25** | *2.15* | 2.25 | 6125 |
| *6126 | Coe's N. E. Special for Potatoes | ...... | ...... | 1.18 | **1.18** | *0.80* | 3.30 | 6.62 | 3.82 | 2.84 | **13.28** | *11.* | **10.44** | *9.* | 10.15 | **2.17** | *2.17* | 2.17 | 6126 |
| *6032 | Coe's Orig. N. E. Tobacco Fertilizer | ...... | 0.93 | 2.44 | **3.37** | *3.25* | 9.43 | 6.76 | 1.96 | 1.41 | **10.13** | *10.* | **8.72** | *9.* | 8.21 | **6.54** | *6.* | 6.54 | 6032 |

* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton † | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton † | |
| ‡*6070 | Coe's Prize Brand Guano | ...... | ...... | 0.73 | **0.73** | *0.41* | $ 2.04 | 8.00 | 3.92 | 2.91 | **14.83** | *12.* | **11.92** | *10.5* | $11.50 | **1.18** | *1.25* | $1.16 | 6070 |
| *5962 | Coe's Red Brand Excelsior Guano | ...... | 0.96 | 2.54 | **3.50** | *3.5* | 9.80 | 6.67 | 2.25 | 1.43 | **10.35** | *10.* | **8.92** | *9.* | 8.38 | **6.41** | *6.* | 6.41 | 5962 |
| *5759 | Coe's Seeding Down & Top Dressing | ...... | ...... | ...... | ...... | ...... | ........ | 7.87 | 4.24 | 1.42 | **13.53** | *14.* | **12.11** | *11.5* | 11.04 | **2.28** | *2.5* | 2.28 | 5759 |
| *6116 | Coe's S. G. Ammo. Bone Superphos. | ...... | ...... | 1.79 | **1.79** | *1.75* | 5.01 | 7.12 | 3.41 | 2.59 | **13.12** | *9.* | **10.53** | *8.* | 10.17 | **1.50** | *1.35* | 1.46 | 6116 |
| ‡*6071 | Coe's XXV Ammo. Bone Superphos | ...... | ...... | 1.16 | **1.16** | *1.* | 3.25 | 7.50 | 4.11 | 2.30 | **13.91** | *9.* | **11.61** | *8.* | 10.96 | **1.03** | *1.* | 1.01 | 6071 |
| ‡6072 | Crocker's Ammo. Bone Superphos | ...... | ...... | 3.13 | **3.13** | *2.9* | 8.76 | 6.69 | 3.97 | 1.15 | **11.81** | *11.* | **10.66** | *10.* | 9.66 | **1.19** | *1.08* | 1.01 | 6072 |
| ‡5927 | Crocker's Ammo. Corn Phosphate | ...... | ...... | 2.09 | **2.09** | *2.* | 5.85 | 6.54 | 3.59 | 1.19 | **11.32** | *11.* | **10.13** | *10.* | 9.23 | **1.87** | *1.6* | 1.59 | 5927 |
| ‡5926 | Crocker's New Rival Ammo. Bone | ...... | ...... | 1.32 | **1.32** | *1.23* | 3.70 | 6.02 | 4.45 | 1.56 | **12.03** | *11.* | **10.47** | *10.* | 9.60 | **1.80** | *1.6* | 1.53 | 5926 |
| ‡5928 | Crocker's Potato, Hop and Tobacco | ...... | ...... | 2.28 | **2.28** | *2.* | 6.38 | 6.89 | 3.11 | 1.23 | **11.23** | *11.* | **10.00** | *10.* | 9.18 | **3.32** | *3.25* | 2.82 | 5928 |
| 5990 | Crocker's Special Potato Manure | ...... | 1.66 | 2.11 | **3.77** | *3.7* | 10.56 | 6.74 | 2.25 | 0.29 | **9.28** | *9.* | **8.99** | *8.* | 7.99 | **5.24** | *5.4* | 4.45 | 5990 |
| ‡¶6093 | Crocker's Superior Fertilizer | ...... | ...... | 0.85 | **0.85** | *0.82* | 2.38 | 4.24 | 3.93 | 1.17 | **9.34** | *9.* | **8.17** | *8.* | 7.43 | **2.10** | *2.* | 1.79 | 6093 |
| ‡6068 | Cumberland Fertilizer for all Crops | ...... | ...... | 1.10 | **1.10** | *1.03* | 3.08 | 5.79 | 2.68 | 1.93 | **10.40** | *10.* | **8.47** | *8.* | 8.13 | **2.33** | *2.* | 1.98 | 6068 |

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¶This brand is likewise sold as "Superior Rye and Oats Fertilizer."

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| ‡5916 | Cumberland Potato Fertilizer.......... | 0.30 | ...... | 1.77 | 2.07 | *2.06* | $ 5.74 | 4.62 | 4.52 | 3.02 | 12.16 | *11.* | 9.14 | *9.* | $ 8.98 | 2.98 | *3.* | $2.53 | 5916 |
| ‡6089 | Cumberland Seeding Down Manure. | ...... | ...... | 1.16 | 1.16 | *1.03* | 3.25 | 5.82 | 2.67 | 1.91 | 10.40 | *10.* | 8.49 | *8.* | 8.14 | 2.46 | *2.* | 2.09 | 6089 |
| ‡5915 | Cumberland Superphosphate........... | 0.34 | ...... | 1.92 | 2.26 | *2.06* | 6.26 | 6.02 | 4.08 | 2.02 | 12.12 | *10.* | 10.10 | *8.* | 9.49 | 2.22 | *2.* | 1.89 | 5915 |
| ‡5936 | Great Eastern General Fertilizer...... | ...... | ...... | 1.05 | 1.05 | *0.82* | 2.94 | 6.36 | 2.36 | 1.01 | 9.73 | *9.* | 8 72 | *8.* | 8.02 | 4.37 | *4.* | 3.71 | 5936 |
| ‡5935 | Great Eastern Grass and Oats Fert... | ...... | ...... | ...... | ...... | ...... | ........ | 7.14 | 3.64 | 1.31 | 12.09 | *12.* | 10.78 | *11.* | 9.86 | 2.10 | *2.* | 1.78 | 5935 |
| ‡6069 | Great Eastern Northern Corn Special | ...... | 0.27 | 2.79 | 3.06 | *3.* | 8.57 | 6.58 | 2.49 | 1.36 | 10.43 | *9.* | 9.07 | *8.* | 8.46 | 2.29 | *2.* | 1.95 | 6069 |
| ‡5934 | Great Eastern Potato Manure.......... | ...... | ...... | 2.38 | 2.38 | *2.06* | 6.66 | 6.03 | 2.40 | 2.00 | 10.43 | *9.* | 8.43 | *8.* | 8.15 | 4.28 | *4.* | 3.64 | 5934 |
| ‡6092 | Lister's Animal Bone and Potash..... | ...... | ...... | ...... | ...... | ...... | ......... | 6.58 | 3.07 | 0.58 | 10.23 | *10.* | 9.65 | *9.* | 8.61 | 4.90 | *5.* | 4.15 | 6092 |
| ‡*6073 | Lister's Oneida Special.................. | ...... | ...... | 0.91 | 0.91 | *0.62* | 2.55 | 8.69 | 2.06 | 1.25 | 12.00 | *11.* | 10.75 | *10.* | 9.97 | 1.12 | *1.* | 1.10 | 6073 |
| 6041 | Lister's Potato Manure..................... | ...... | 1.33 | 2.35 | 3.68 | *3.7* | 10.30 | 6.83 | 1.72 | 1.37 | 9.92 | *8.5* | 8.55 | *7.5* | 8.07 | 6.83 | *7.* | 5.81 | 6041 |
| ¶‡5904 | Lister's Special Potato Fertilizer....... | ...... | 0.19 | 1.60 | 1.79 | *1.65* | 5.01 | 6.25 | 2.61 | 2.01 | 10.87 | *9.* | 8.86 | *8.* | 8.52 | 3.30 | *3.* | 2.90 | 5904 |

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¶Potash partly as sulphate. ‡Reprinted from Bulletin 64

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND. | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates. | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| ‡§6075 | Lister's Special Potato Fertilizer...... | ...... | ...... | 1.82 | 1.82 | *1.65* | $5.10 | 5.94 | 2.88 | 2.30 | 11.12 | *9.* | 8 82 | *8.* | $ 8.57 | 3 04 | *3.* | $2.58 | 6075 |
| ¶‡6074 | Lister's Special Corn Fertilizer........ | ...... | ...... | 1.80 | 1.80 | *1.65* | 5.04 | 6.29 | 2.60 | 2.21 | 11 10 | *9.* | 8.89 | *8.* | 8.63 | 3 05 | *3.* | 2.67 | 6074 |
| ‡5903 | Lister's Success Fertilizer.............. | ...... | 0.19 | 1.26 | 1 45 | *1.24* | 4.06 | 7.25 | 2.74 | 1.89 | 11.88 | *11.5* | 9.99 | *9.5* | 9.47 | 2 36 | *2.* | 2.01 | 5903 |
| ‡6094 | Lowell Swift's Animal Brand......... | ...... | ...... | 2.59 | 2. 59 | *2.47* | 7.25 | 5.89 | 3.19 | 1.74 | 10 82 | *10.* | 9.08 | *9.* | 8.55 | 4 05 | *4.* | 3.44 | 6094 |
| ‡5908 | Lowell Swift's Bone Fertilizer. ....... | ...... | ...... | 1.79 | 1.79 | *1.65* | 5.01 | 5.08 | 3.23 | 1.71 | 10.02 | *9.* | 8.31 | *8.* | 7.84 | 3 33 | *3.* | 2.83 | 5908 |
| ‡6095 | Lowell Swift's D. Bone and Potash.. | ...... | ...... | 1.91 | 1 91 | *1.65* | 5.35 | 6.47 | 2.58 | 2.18 | 11 23 | *10.* | 9 05 | *9.* | 8.76 | 2 24 | *2.* | 1.90 | 6095 |
| *‡5931 | Lowell Swift's Potato Phosphate..... | ...... | 0.19 | 2.67 | 2.86 | *2.47* | 8.01 | 4.85 | 3.80 | 1.43 | 10.08 | *9.* | 8.65 | *8.* | 7.98 | 6.08 | *6.* | 5.94 | 5931 |
| 5865 | P. G. Co.'s Dissolved Bone & Potash | ...... | ...... | ...... | ...... | ...... | ........ | 7.36 | 3.23 | 0.80 | 11 39 | *11.* | 10.59 | *10.* | 9.53 | 2.22 | *2.* | 1.89 | 5865 |
| ‡5925 | P. G. Co.'s Nobsque Guano............ | ...... | ...... | 1.16 | 1.16 | *1.15* | 3.25 | 5.70 | 2.81 | 1.82 | 10 33 | *9.* | 8.51 | *8.* | 8.11 | 2.11 | *2.* | 1.79 | 5925 |
| ‡6065 | P. G. Co.'s Potato Special............. | ...... | ...... | 2.09 | 2.09 | *2.06* | 5.85 | 6.28 | 3.09 | 2.41 | 11.78 | *9.* | 9.38 | *8.* | 9.09 | 3.22 | *3.* | 2.74 | 6065 |
| ‡5924 | P. G. Co.'s Soluble Pacific Guano..... | ...... | ...... | 2.13 | 2.13 | *2.25* | 5.96 | 4.87 | 4.53 | 2.21 | 11.61 | *10.5* | 9.40 | *8.5* | 8.89 | 2.21 | *2.* | 1.88 | 5924 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

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¶Potash partly as sulphate. ‡Reprinted from Bulletin 64. §Second sample analysed through inadvertence.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| ‡6066 | Quinnipiac Climax Phosphate........ | ...... | ...... | 1.24 | **1.24** | *1.03* | $ 3.47 | 5.75 | 2.94 | 2.12 | **10.81** | *9.* | **8.69** | *8.* | $8.38 | **2.25** | *2.* | $1.91 | 6066 |
| ‡5922 | Quinnipiac Corn Manure............... | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 5.86 | 3.93 | 2.14 | **11.93** | *10.* | **9.79** | *9.* | 9.27 | **1.63** | *1.5* | 1.39 | 5922 |
| ‡6097 | Quinnipiac Market Garden Manure.. | 0.46 | 0.61 | 2.50 | **3.57** | *3.3* | 9.90 | 5.07 | 3.59 | 1.77 | **10.43** | *9.* | **8.66** | *8.* | 6.71 | **7.48** | *7.* | 6.36 | 6097 |
| ‡6098 | Quinnipiac Mohawk Fertilizer....... | ...... | ...... | 1.17 | **1.17** | *0.82* | 3.28 | 3.64 | 4.22 | 2.80 | **10.66** | *8.* | **7.86** | *7.* | 7.78 | **1.48** | *1.* | 1.26 | 6098 |
| ‡6099 | Quinnipiac Onion Manure............. | 1.27 | 0.19 | 1.93 | **3.39** | *3.3* | 9.24 | 4.30 | 4.16 | 1.81 | **10.27** | *9.* | **8.46** | *8.* | 7.92 | **7.48** | *7.* | 6.36 | 6099 |
| 5743 | Quinnipiac Phosphate..................... | ...... | ...... | 2.45 | **2.45** | *2.57* | 6.86 | 5.96 | 4.45 | 1.99 | **12.40** | *10.* | **10.41** | *9.* | 9.72 | **2.05** | *2.* | 1.74 | 5743 |
| ‡5923 | Quinnipiac Potato Phosphate......... | ...... | ...... | 2.23 | **2.23** | *2.05* | 6.24 | 6.94 | 2.54 | 1.82 | **11.30** | *9.* | **9.48** | *8.* | 9.01 | **3.28** | *3.* | 2.79 | 5923 |
| ‡6084 | Read's Farmers' Friend Superphos.. | ...... | ...... | 2.39 | **2.39** | *2.1* | 6.69 | 7.72 | 2.39 | 1.22 | **11.33** | *10.* | **10.11** | *9.* | 9.35 | **2.60** | *2.* | 2.21 | 6084 |
| ‡6104 | Read's Fish, Bone and Potash......... | ...... | ...... | 2.30 | **2.30** | *2.47* | 6.44 | 2.29 | 2.11 | 2.52 | **6.92** | *5.* | **4.44** | *4.* | 4.76 | **4.31** | *4.* | 3.66 | 6104 |
| ‡6085 | Read's Leader Guano..................... | ...... | ...... | 1.13 | **1.13** | *0.83* | 3.16 | 4.84 | 2.43 | 1.28 | **8.55** | *8.* | **7.27** | *7.* | 6.81 | **2.30** | *2.* | 1.95 | 6085 |
| ‡5933 | Read's Practical Potato Special....... | ...... | ...... | 1.08 | **1.08** | *0.83* | 3.02 | 2.67 | 1.91 | 1.00 | **5.58** | *5.* | **4.58** | *4.* | 4.33 | **8.38** | *8.* | 7.12 | 5933 |

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*Potash in brands thus marked is largely if not entirely in the form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†"Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52 of Bulletin 63. ‡Reprinted from Bulletin 64.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| ‡6103 | Read's Sampson for Potatoes | ...... | ...... | 2.32 | **2.32** | *1.65* | $ 6.50 | 5.84 | 2.52 | 1.46 | **9.82** | *7.* | **8.36** | *6.* | $7.86 | **4.82** | *4.* | $4.10 | 6103 |
| ‡6083 | Read's Standard Superphosphate | ...... | ...... | 1.09 | **1.09** | *0.83* | 3.05 | 6.15 | 2.57 | 1.13 | **9.85** | *9.* | **8.72** | *8.* | 8.04 | **4.02** | *4.* | 3.42 | 6083 |
| ‡6086 | Read's Sure Catch Fertilizer | ...... | ...... | ...... | ...... | ...... | ........ | 3.61 | 3.55 | 1.00 | **8.16** | *7.* | **7.16** | *6.* | 6.49 | **4.06** | *4.* | 3.45 | 6086 |
| ‡6105 | Read's Vegetable and Vine Fert | ...... | ...... | 1.91 | **1.91** | *1.65* | 5.35 | 4.34 | 2.08 | 1.74 | **8.16** | *7.* | **6.42** | *6.* | 6.27 | **8.41** | *8.* | 7.15 | 6105 |
| ‡6079 | R. C. Co.'s Essex, Corn, Grain, Grass | 0.65 | ...... | 3.63 | **4.28** | *3.7* | 11.85 | 3.77 | 4.74 | 3.11 | **11.62** | *9.5* | **8.51** | *7.* | 8.43 | **9.89** | *9.5* | 8.41 | 6079 |
| ‡*6080 | R. C. Co.'s Essex, Potatoes & Roots | 0.40 | 0.53 | 3.45 | **4.38** | *3.7* | 12.08 | 3.64 | 4.95 | 2.45 | **11.04** | *9.* | **8.59** | *7.* | 8.22 | **8.90** | *8.5* | 8.82 | 6080 |
| ‡5933 | R. C. Co.'s Essex XXX Fish & Pot. | ...... | ...... | 2.50 | **2.50** | *2.1* | 7.00 | 6.67 | 2.87 | 3.64 | **13.18** | *12.* | **9 54** | *10.* | 9.76 | **2.32** | *2.25* | 1.97 | 5933 |
| 5976 | R. C. Co.'s High Grade Superphos. | 0.71 | ...... | 2.27 | **2.98** | *2.5* | 8.21 | 2.50 | 7.26 | 4.15 | **13.91** | *11.* | **9.76** | *9.* | 9.72 | **4.80** | *4.* | 4.08 | 5976 |
| ‡5620 | Standard Fertilizer | 0.47 | ...... | 1.72 | **2.19** | *2.06* | 6.04 | 4.84 | 4.26 | 2.52 | **11.62** | *10.* | **9.10** | *8.* | 8.77 | **2.22** | *2.* | 1.89 | 5620 |
| 5826 | Standard Guano for all Crops | ...... | ...... | 1.14 | **1.14** | *1.03* | 3.19 | 6.31 | 1.75 | 2.07 | **10.13** | *10.* | **8.06** | *8.* | 7.91 | **2.35** | *2.* | 2.00 | 5826 |
| ‡6101 | Standard Special for Potatoes | ...... | ...... | 2.09 | **2.09** | *2.05* | 5.85 | 7.00 | 2.67 | 1.82 | **11.49** | *9.* | **9.67** | *8.* | 9.17 | **3.36** | *3.* | 2.86 | 6101 |

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*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," pages 50–52 of Bulletin 63. ‡Reprinted from Bulletin 64.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| 6127 | Tucker's Imperial for all Crops........ | ...... | ...... | 1.29 | **1.29** | *1.23* | 3.61 | 5.88 | 2.71 | 2.43 | **11.02** | *11.* | **8.69** | *9.* | 8.43 | **2.25** | *1.85* | 1.91 | 6127 |
| ‡5929 | Tucker's Imperial for Corn.............. | ...... | ...... | 1.32 | **1.32** | *1.23* | 3.70 | 5.82 | 2.76 | 1.81 | **10.39** | *11.* | **8.58** | *9.* | 8.17 | **2.30** | *1.85* | 1.96 | 5929 |
| ‡5930 | Tucker's Imperial for Potatoes ........ | ...... | ...... | 1.53 | **1.53** | *1.23* | 4.28 | 5.71 | 2.93 | 1.90 | **10.54** | *11.* | **8.64** | *9.* | 8.24 | **2.47** | *1.85* | 2.10 | 5930 |
| 5952 | Tucker's Original Bay State Fert....... | ...... | ...... | 2.17 | **2.17** | *2.06* | 6.08 | 5.03 | 4.16 | 2.23 | **11.42** | *11.* | **9.19** | *9.* | 8.75 | **2.24** | *2.* | 1.90 | 5952 |
| ‡§6108 | Tucker's Special Potato Fertilizer..... | ...... | ...... | 2.22 | **2.22** | *2.06* | 6.22 | 2.72 | 4.24 | 3.38 | **10.34** | *9.* | **6.96** | *8.* | 7.19 | **5.83** | *6.* | 4.96 | 6108 |
| ‡6096 | W. & C. Co 's Amer. A. B. Super..... | ...... | ...... | 2.57 | **2.57** | *2.47* | 7.20 | 6.72 | 3.64 | 1.96 | **12.32** | *10.* | **10.36** | *9.* | 9.74 | **2.29** | *2.* | 1.95 | 6096 |
| ‡5907 | W. & C. Co.'s Americus Corn Phos.. | ...... | ...... | 2.13 | **2.13** | *2.06* | 5.96 | 5.91 | 3.89 | 2.15 | **11.95** | *10.* | **9.80** | *9.* | 9.29 | **1.76** | *1.5* | 1.50 | 5907 |
| ‡5905 | W. & C. Co.'s Americus Potato Man | ...... | ...... | 2.14 | **2.14** | *2.06* | 5.99 | 6.01 | 3.12 | 2.65 | **11.78** | *9.* | **9.13** | *8.* | 8.97 | **3.29** | *3.* | 2.80 | 5905 |
| 5732 | W. & C. Co.'s High Grade Special ... | 0.87 | 0.48 | 1.92 | **3.27** | *3.3* | 8.97 | 5.75 | 3.21 | 1.57 | **10.53** | *9.* | **8.96** | *8.* | 8.38 | **6.83** | *7.* | 5.81 | 5732 |
| ‡6090 | W. & C. Co.'s Prolific Crop Producer | ...... | ...... | 1.16 | **1.16** | *0.82* | 3.25 | 3.57 | 4.39 | 2.76 | **10.72** | *7.* | **7.96** | *6.* | 7.83 | **1.34** | *1.* | 1.14 | 6090 |
| ‡5906 | W. & C. Co.'s Royal Bone Phos ...... | ...... | ...... | 1.18 | **1.18** | *1.03* | 3.30 | 5.83 | 2.87 | 1.62 | **10.32** | *8.* | **8.70** | *7.* | 8.19 | **2.65** | *2.* | 2.18 | 5906 |

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*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

## V. COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1897 AND IN 1898.

Of the 167 brands of commercial fertilizers sold in the state during 1897 and 1898 and found by our sampling agents, 96 have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands have been chosen which have been found by us both years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1897 AND 1898

| Name of ingredient | 1897 | | 1898 | |
|---|---|---|---|---|
| | Pounds in a hundred | Valuation at 1898 prices | Pounds in a hundred | Valuation at 1898 prices |
| Nitrogen | 2.11 | $5 91 | 2.13 | $5 96 |
| Soluble Phosphoric Acid | 5.71 | 5 14 | 5.55 | 5 00 |
| Reverted Phosphoric Acid | 3.30 | 2 64 | 3.38 | 2 70 |
| Insoluble Phosphoric Acid | 2.08 | 0 83 | 2.17 | 0 87 |
| Available Phosphoric Acid | 9.01 | | 8.95 | |
| Total Phosphoric Acid | 11.09 | | 11.10 | |
| Potash | 3.27 | 2 78 | 3.53 | 3 00 |
| Total valuation per ton | | $17 30 | | $17 53 |

The table indicates that the average composition of these 96 brands has changed but slightly. Nitrogen and available phosphoric acid percentages are almost identical, while potash is increased a quarter of one per cent and, consequently, the average valuation is bettered a quarter of a dollar. Selling prices have held about the same. The average of selling prices of all the brands as reported by the sampling agents, shows a very slight decrease. Consequently the average cost of plant food, as retailed to the Vermont buyer of mixed goods, is the same as last year.

In this connection the following table showing the averages for the years 1885–1898 of analyses, selling prices, valuations, money value of plant food bought for a dollar, and valuations of all at 1898 trade values, may prove of interest. All brands analyzed each year since the station has had charge of this class of work are included in the comparison, each brand being given equal value, which, while not strictly a correct method of calculation, is the best which can be done in the absence of data showing the consumption of individual brands. Inasmuch as high grade goods sell slowly and low grade brands readily, the actual average as used is probably much lower than that shown in the table.

AVERAGE ANALYSES, SELLING PRICES, VALUATIONS, ETC., 1885–1898

| Year | Number of brands analyzed | Nitrogen | Phosphoric Acid |  |  |  |  | Potash | Average selling price | Average valuation at each years' trade value | Value of plant food received for each dollar paid out | Average valuation at 1898 trade values |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Soluble | Reverted | Insoluble | Total | Available |  |  |  |  |  |
|  |  | % | % | % | % | % | % | % | $ | $ | cts. | $ |
| 1885 | 37 | 2.38 | 6.35 | 1.93 | 2.13 | 10.41 | 8.28 | 2.77 | 37.90 | 26.72 | 71 | 17.13 |
| 1886 | 25 | 2.58 | 6.15 | 1.92 | 2.59 | 10.66 | 8.07 | 2.69 | 37.02 | 25.75 | 70 | 17.62 |
| 1887 | 30 | 2.75 | 5.48 | 3.23 | 2.52 | 11.23 | 8.71 | 2.84 | 36.75 | 27.15 | 74 | 18.64 |
| 1888 | 31 | 2.80 | 6.74 | 2.80 | 2.56 | 12.10 | 9.54 | 3.12 | 35.13 | 28.96 | 82 | 19.82 |
| 1889 | 28 | 2.55 | 6.68 | 2.97 | 2.98 | 12.63 | 9.65 | 2.69 | 35.11 | 29.05 | 83 | 19.01 |
| 1890 | 31 | 2.41 | 5.99 | 2.97 | 2.71 | 11.67 | 8.96 | 3.16 | 34.39 | 26.70 | 78 | 18.29 |
| 1891 | 22 | 2.52 | 6.47 | 2.86 | 2.00 | 11.33 | 9.33 | 3.13 | 33.14 | 26.07 | 79 | 18.63 |
| 1892 | 34 | 2.42 | 6.47 | 2.60 | 2.18 | 11.25 | 9.07 | 2.82 | 32.47 | 24.48 | 75 | 17.95 |
| 1893 | 36 | 2.41 | 6.44 | 2.84 | 2.34 | 11.62 | 9.28 | 2.64 | 32.32 | 23.53 | 73 | 18.00 |
| 1894 | 53 | 2.21 | 5.42 | 2.97 | 2.16 | 10.55 | 8.39 | 2.95 | 31.47 | 21.47 | 68 | 16.81 |
| 1895 | 92 | 2.22 | 5.84 | 2.56 | 2.53 | 10.93 | 8.40 | 3.46 | 30.90 | 21.28 | 69 | 17.47 |
| 1896 | 110 | 2.22 | 5.36 | 3.44 | 2.22 | 11.02 | 8.80 | 3.66 | 30.90 | 19.73 | 64 | 17.79 |
| *1897 | 134 | 2.12 | 5.34 | 3.68 | 2.23 | 11.25 | 9.02 | 3.43 | 29.19 | 19.47 | 67 | 17.59 |
| *1898 | 126 | 2.21 | 5.51 | 3.32 | 2.08 | 10.91 | 8.83 | 3 81 | 29.04 | 17.86 | 61 | 17.86 |

This table gives a good idea of the character of the trade of the past 14 years. Up to 1894 but a small number of brands were sold, but during the past 5 years competition has been increasingly active and both the number of brands and the sales have multiplied.

Because of reasons already given, an exact statement of the average grade of the goods used each year since 1885 cannot be made. Yet it is safe to say that it is lower to-day, speaking commercially, than that sold 10 years ago. The average fertilizers of the past 5 years contain less nitrogen and available phosphoric acid, but more potash. Large numbers of low grade goods have lowered the former figure, while many brands rich in potash have served to raise the average for that ingredient. The trade conditions of the past four years have been fairly uniform, the average grade has not changed materially and valuations on the same (1898) basis have varied but 2 per cent.

The most significant figures appear under the caption "Value of plant food received for each dollar paid out." Dividing the data into three groups the following showing is made:

|  | In 1885-87. | In 1888-93. | In 1894-98. |
|---|---|---|---|
| Average selling price was, | $37.22 | $33.76 | $30.30 |
| Average valuation was, | 26.54 | 26.46 | 19.88 |
| A dollar bought of plant food, | 72 cts. worth | 78 cts. worth | 66 cts. worth. |

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* Omitting 6 non-nitrogenous goods analysed in 1897, and 5 in 1898, the nitrogen average of the former year becomes nearly the same as in 1895-96, and of 1898 becomes rather better. It also causes available phosphoric acid to drop 0.05 per cent while potash remains unchanged.

Average goods cost more and contained less plant food in 1885-87 than in 1888-93, while during the past 5 years average grade and cost have both been less than in former years. Average selling prices lessen each year, but the shrinkage is not in proportion to the drop in the cost of the raw materials. Nitrogen cost in 1898 but three-quarters and available phosphoric acid only half what it did in 1885, potash remaining the same in price. The average goods of 1885 "value" at 1898 prices but 64 per cent of what they figure at the trade values of the year of their manufacture. Their selling price to-day, however, probably would be not far from 77 per cent of that of 1885. Good reasons exist for this condition. The expenses, over and above the cost of the unmanipulated raw material of plant food, entailed by the present system of manufacture and sale are little if any lower now than they were in years gone by; hence they form a larger proportion of the total cost of commercial fertilizers than hitherto.

Plant food in mixed goods is as cheap to-day as it has been in the past. Yet since on the average 40 cents on a dollar is paid for charges other than the retail cost of the plant food, a proportion larger than has been hitherto met, it follows that the buyer of mixed goods should observe the relation between selling price and valuation even more carefully than in the past. It is equally clear that the direct purchase of the raw materials (nitrate of soda, cottonseed meal, dried blood, tankage, dried ground fish, ground bone, acid phosphate, muriate of potash, sulphate of potash, etc.) for home mixing is proportionately more profitable to-day than ever before. Attention is called to the analyses of home mixed fertilizers and the experience of Vermont farmers with the same as given on the following pages.

## VI. ANALYSES OF MISCELLANEOUS FERTILIZERS.

### 1. HOME MIXTURES.

Most users of commercial fertilizers buy mixed goods. This method of purchase is frequently the best, provided wise choice is made. The well-informed farmer, however, can often get better grades at lower figures by buying the raw materials and mixing them to suit his special needs. The man who knows what he wants and pays cash for crude stock gets plant food for much less than does the credit buyer of mixed goods. Many manufacturers are glad to cater to this class of trade and to make quotations to it. They find it quite as profitable as to sell at higher prices on credit, doing what is essentially a banking business for their customers. The individual farmer himself must decide which method of purchase best meets his conditions; whether as a matter of convenience, and to avoid the necessity of study, a little bother and cash payment, he will pay a dollar for 60 cents worth of plant food, or, by the exercise of a little business energy and foresight, get from 80 to 90 cents worth for the same outlay.

The state law governing the sale of commercial fertilizers takes no cognizance of crude stock and does not interfere with the freedom of purchase by individuals. Hence the farmer may buy of whom he will and is not confined to trading with the licensed companies. The addresses of such firms as are licensed to sell mixed goods in this state will be found on page 82. Most if not all of these concerns are glad to quote prices on raw materials. The addresses of other firms which make a specialty of dealing in crude stock will be furnished on application.

Home mixing has been largely practised in states to the south of Vermont for many years and has become not uncommon here within the past five years. The pros and cons, the experience of New Jersey farmers, the character of the goods made, etc., were commented upon in Bulletin 47 of this station. It has seemed worth while to note what Vermonters have to say of home mixing. Attention is called to the following table showing analyses, calculations, valuations and cost of 16 home mixed fertilizers, 3 made by the station for its own use, and of 13 made by eight farmers. The first 7 were made in 1897, the last 9 in 1898. Valuations are calculated using the trade value schedule of the year in which the goods were made. In most cases these parties have sent for analysis samples of the crude stocks used and have furnished the formulas on which the goods were mixed, thus enabling calculation of what the goods ought to contain if well mixed.

Sample No. 5581 represents a lot of dove guano. Assuming that this sample properly represents the material, it is a very rich nitrogenous manure.

Sample No. 5599 represents a lot of mixed rotted manure.

# ANALYSES OF HOME MIXTURES, ETC.

| Station Number | MADE BY | NITROGEN | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Cost of Material Delivered at Consumer's Depot | Total Value of Plant Food at Station Valuations | Value in Plant Food Bought for a Dollar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Organic Matter | Total Found | Total Calculated | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Calculated | Valuation of Potash in One Ton† | | | |
| | | | | | | | | | | Found | Calculated | Found | Calculated | | | | | | | |
| 5582 | E. S. Brigham, St. Albans..... | 1.60 | 1.72 | **3.32** | *3.52* | $ 9.30 | 8.05 | 1.70 | 0.42 | **10.17** | *9.98* | **.75** | *9.5* | $10.72 | **9.86** | *10.28* | $ 8.87 | $29.60 | $28.89 | $0.98 |
| 5587 | W. W. Jones, Randolph........ | ...... | 2.85 | **2.85** | ...... | 7.98 | 0.10 | 1.57 | 0.23 | **1.90** | ....... | **.67** | ...... | 1.77 | **4.99** | ....... | 4.49 | ......... | 14.24 | ........ |
| 5588 | E. Hitchcock, Pittsford......... | 1.60 | 1.31 | **2.91** | *3.17* | 8.15 | 4.14 | 4.18 | 0.35 | **8 67** | *9.78* | **8.32** | *8.* | 8.87 | **8.18** | *8.53* | 7.36 | 25.65 | 24.38 | 0.95 |
| 5589 | E. Hitchcock, Pittsford......... | ? | ? | **4.00** | *4.27* | 11.20 | 1.31 | 4.27 | 2.17 | **7.75** | *8.41* | **5.58** | *5.75* | 6.58 | **10.95** | *10.67* | 9.85 | 29.00 | 27.63 | 0.95 |
| 5604 | L. J. Sanderson, Highgate..... | 1.20 | 1.79 | **2.99** | *3.13* | 8.37 | 2.73 | 4.81 | 3.85 | **11.39** | *10.95* | **7.54** | *8.55* | 9.35 | **5.22** | *5.05* | 4.70 | 23.40 | 22.42 | 0.96 |
| 5605 | L. J. Sanderson, Highgate..... | 1.20 | 1.45 | **2 65** | *2.63* | 7.42 | 2.82 | 4.87 | 3.89 | **11.58** | *10.95* | **7.69** | *8.8* | 9.53 | **6.69** | *7.55* | 6.02 | 24.10 | 22.97 | 0.95 |
| *5612 | A. W. Gilman, Middlet'n Sps. | 0.84 | 1.97 | **2.81** | *3.7* | 7.87 | 8.71 | 2.61 | 1.68 | **13.00** | *9.1* | **11.32** | ...... | 12.86 | **10.13** | *8.* | 10.13 | 30.90 | 30.86 | 1.00 |
| 6139 | M. E. Bemis, Marshfield........ | ...... | 1.34 | **1.34** | *1.2* | 3.75 | 5.92 | 3.16 | 0.84 | **9.92** | *10.5* | **9.08** | *9.9* | 8.19 | **5.31** | *4.2* | 4.51 | 22.30 | 16.45 | 0.74 |
| *6136 | M. E. Bemis, Marshfield........ | 2.08 | ...... | **2.08** | *2.7* | 5.41 | 5.39 | 2.49 | 0.60 | **8.48** | *7.* | **7.88** | *6.5* | 7.08 | **7.87** | *8.3* | 7.87 | 30.80 | 20.36 | 0.66 |
| 6137 | M. E. Bemis, Marshfield........ | ...... | ...... | ...... | ...... | ......... | 6.34 | 2.61 | 0.68 | **9.63** | *10.5* | **8.95** | *9.8* | 8.07 | **11.11** | *12.5* | 9.44 | 26.25 | 17.51 | 0.67 |
| 6015 | L. C. Ray, Shelburne............ | ...... | 3.58 | **3.58** | *3.5* | 10.02 | 0.05 | 8.43 | 4.85 | **13.33** | *13.* | **8.48** | ...... | 8.72 | **1.37** | *1.1* | 1.16 | ......... | 19.90 | ........ |
| 6140 | W. R. Curtis, Jericho............ | 0.60 | 1.76 | **2.36** | *2.3* | 6.49 | 6.46 | 1.54 | 0.64 | **8.64** | *10.1* | **8.00** | *9.* | 7.30 | **9.08** | *9.* | 7.72 | 26.20 | 21.51 | 0.82 |
| 6141 | W. R. Curtis, Jericho............ | 0.56 | 1.03 | **1.59** | *1.75* | 4.34 | 7.58 | 1.62 | 0.59 | **9.79** | *10.24* | **9.20** | *9.07* | 8.35 | **9.09** | *12.* | 7.73 | 27.30 | 20.42 | 0.75 |
| 6142 | Experiment Station............... | 0.99 | 2.62 | **3.61** | *3.65* | 9.91 | 3.78 | 4.68 | 4.14 | **12.60** | *12.44* | **8.46** | *8.77* | 8.80 | **4.88** | *5.23* | 4.15 | 25.30 | 22.86 | 0.90 |
| 6144 | Experiment Station............... | 1.06 | 2.09 | **3.15** | *3.58* | 8.61 | 3.43 | 3.33 | 3.34 | **10.10** | *9.83* | **6 76** | *6.92* | 7.09 | **13.31** | *12.41* | 11.31 | 28.60 | 27.01 | 0.94 |
| *6143 | Experiment Station............... | 1.49 | 1.72 | **3.21** | *3.58* | 8.69 | 2.80 | 4.08 | 3.97 | **10.85** | *9.83* | **6.88** | *6.92* | 7.37 | **12.37** | *12.41* | 12.37 | 30.20 | 28.43 | 0.94 |
| 5581 | L. M. Averill, Barre.............. | ...... | ...... | **2.94** | ...... | ......... | ...... | ...... | ...... | **1.62** | ....... | ....... | ...... | ......... | **0.96** | ....... | ......... | ......... | ......... | ........ |
| 5599 | E. C. Orvis, Manchester....... | ...... | ...... | **0.31** | ...... | ......... | ...... | ...... | ...... | **0.34** | ....... | ....... | ...... | ......... | **0.16** | ....... | ......... | ......... | ......... | ........ |

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***Potash as sulphate.**

**† "Valuation" does not represent proper selling price in Vermont but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial value of Commercial Fertilizers," pages 50-52 of Bulletin 63.**

Study of the foregoing table brings out the following points:

1. *Mixing.* Mixing has been done on the farm with sufficient evenness for most purposes. In several cases no analysis of the crude stock was made, and averages rather than actual figures were used in calculating from formulas. The comparisons where analyses are at hand are as a rule reasonably close, yet a few discrepancies occur, due largely it is thought to the lumpy condition of either the potash salts or the nitrate of soda.

EXCESS OR DEFICIENCY OF ACTUAL ANALYSIS AS COMPARED WITH CALCULATION

| Nitrogen | Total Phos. Acid | Avail. Phos. Acid | Potash |
|---|---|---|---|
| —0.20 | +0.19 | +0.25 | —0.42 |
| —0.26 | —1.12 | +0.32 | —0.35 |
| —0.27 | —0.66 | —0.17 | +0.28 |
| —0.14 | +0.44 | —1.01 | +0.17 |
| +0.02 | +0.63 | —1.11 | —0.86 |
| +0.08 | +0.33 | —— | +0.27 |
| +0.06 | —1.46 | —1.00 | +0.08 |
| —0.16 | —0.45 | +0.13 | —2.91 |
| —0.04 | +0.16 | —0.31 | —0.35 |
| —0.43 | +0.27 | —0.16 | +0.90 |
| —0.37 | +1.02 | —0.04 | —0.04 |

2. *Grade of Goods.* The goods varied decidedly in composition. Nitrogen ranged from 0 to 4.00 per cent, available phosphoric acid from 1.67 to 11.32 per cent, potash from 1.31 to 13.31 per cent. Omitting one sample in which hen manure was largely used, and one made of low grade tankage with but little potash, the average composition was as shown in the following table. The average mixed goods as put out this year by manufacturers is shown also:

COMPARISON OF COMPOSITIONS OF HOME AND OF MANUFACTURERS' MIXTURES

| | Nitrogen | Total Phosphoric Acid | Available Phosphoric Acid | Potash |
|---|---|---|---|---|
| Average of 14 home mixtures............... | 2.57 | 10.19 | 8.25 | 8.86 |
| Average of 126 manufacturers' mixtures | 2.21 | 10.91 | 8.83 | 3.81 |

The home mixtures averaged higher in nitrogen, lower in phosphoric acid and more than twice as high in potash. Twelve of the 16 samples were in every sense of the term high grade fertilizers, made of the best forms of crude stock and rich in plant food. They averaged far better than average manufacturers' mixtures and were, as a whole, as good as the best.

3. *Financial Results.* The goods represented by the first 7 analyses were made in 1897, while the remainder were mixed in 1898. Valuations are figured for each lot using the schedule of trade values for the year of its manufacture. Comparing each lot with the average for manufacturers' goods of the same year the following showing is made:

FINANCIAL COMPARISON OF HOME AND OF MANUFACTURERS' MIXTURES

| 1897. | Number of samples | Cost* | Valuation | Value of plant food bought for a dollar |
|---|---|---|---|---|
| Home mixtures | 6 | $27.10 | $26.19 | $0.97 |
| Manufacturers' mixtures | 134 | 29.19 | 19.47 | 0.67 |
| Brand offering most plant food for a dollar in 134 brands | 1 | 36.00 | 30.97 | 0.86 |
| 1898. | | | | |
| Home mixtures | 8 | $27.10 | $21.82 | 0.81 |
| Manufacturers' mixtures | 126 | 29.04 | 17.86 | 0.61 |
| Brand offering most plant food for a dollar in 126 brands | 1 | 37.00 | 29.12 | 0.79 |

Both years average home mixtures cost $2.00 less, and valued from $4.00 to $6.75 more than average manufacturers' goods. Both years more plant food was bought for a dollar in *average* home mixtures than was bought in the brand of manufacturers' goods which gave the most plant food for the cost. The saving was 45 per cent in 1897 and 30 per cent in 1898. This showing is made despite the fact that the 1898 average is seriously lowered by the high prices paid by one home mixer for his raw materials. This party bought of the local agent and paid two profits instead of dealing directly with the manufacturer and paying but a single profit. To make the saving above noted the home mixer is called upon to do a little studying, a little shovelling (costing on the average less than a dollar to the ton of mixture) and to pay cash. It is safe to say that even when as little as a ton is used HOME MIXING PAYS.

Seven of the eight parties (not including the station), whose goods figure in the table on page 112 were asked a series of questions touching the practicality of home mixing. Their replies are summarized below:

1. They had practised home mixing for 2 years or less.
2. They had made from 1 to 6 tons yearly.
3. They had found no difficulty in getting low quotations.
4. They had found no difficulty in mixing.
5. The mechanical condition (fineness) of the goods was satisfactory in 5 cases; two reported lumpiness of the nitrate of soda an obstacle; one of the latter overcame this by having the nitrate milled before using.
6. Three estimate cost of mixing at 50 cents a ton, three at a dollar, while one states that the work was done at odd spells and makes no money estimate.
7. Five state that the goods gave good field results, one that they were the best ever obtained, and one mixed for the first time in 1898.
8. The goods were used on corn, potatoes, onions, etc.

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*Cost does not include mixing in home mixtures or, at points remote from railroads, hauling from depot, charges which are included in manufacturers' mixtures.

9. Six state that home mixing paid; one mixed for the first time in 1898, and states that if field results are satisfactory it will prove a paying operation.

10. The following advantages and disadvantages are pointed out by the seven farmers.

*a. Advantages:* Better goods for less money, giving as good or better results than the commercial brands.

Mixtures to meet special needs of soil or crop.

Educational value.

*b. Disadvantages:* None.

The objections to this method of buying plant food most commonly urged are:

1. That not enough is saved to make it pay.
2. That farmers cannot make perfect mixtures.
3. That farmers cannot formulate mixtures that will do good service.
4. That it is a fussy and costly task to mix the goods.

Most of these objections have been shown in the past to be fallacious, and again are proved to be without basis in fact by the cases here cited. The parties whose goods have been analysed at this station did make it pay, did mix with a sufficient degree of evenness, many of them made mixtures better adapted for their uses than the majority of mixed commercial brands sold in the state, and they do not seem to lay stress on the difficulty of mixing. It would appear as if the final objection alone is worthy of consideration. Those to whom it appeals, who prefer to buy mixed goods rather than raw materials, might well combine and buy fertilizers of specified composition made from standard crude stock on competitive bidding by manufacturers. This method of purchase is largely in vogue in some localities and is decidedly preferable to that commonly practised.

## FORMULAS FOR HOME MIXING.

The station officers are often asked to furnish formulas for fertilizers. The table on page 117 affords a sufficient variety to meet most Vermont farm needs. The materials used therein (nitrate of soda, cottonseed meal, acid phosphate, muriate of potash) are those which of late years have furnished available plant food of the best quality at lowest rates. Approximately one-third of the total nitrogen in each formula occurs as nitrate. Equal weights of sulphate of potash may be substituted for muriate if desired. Linseed or the richer brands of gluten meal may replace the cottonseed without much reduction in the nitrogen percentage. In case animal ammoniates are used in place of cottonseed meal, similar quantities of medium grade tankage or fish scrap, or two-thirds the amount of dried blood or of flesh meal will furnish approximately the same amount of nitrogen, and the two former will add to the phosphoric acid percentage. For seeding down, ground bone may be used to advantage in place of some of the cottonseed meal and acid phosphate.

The table gives formulas in which relatively small, medium and large quantities each of nitrogen, available phosphoric acid and potash are combined with varying quantities of the other two ingredients. The terms low, medium and high for the three ingredients cover the following percentages.

| | | | | | | |
|---|---|---|---|---|---|---|
| Nitrogen, | low, | 1.2-1.5, | medium, | 2.0-2.5, | high, | 3.0- 4.0 |
| Available Phosphoric Acid, | " | 5.7-6.0, | " | 7.4-8.4, | " | 9.3-11.0 |
| Potash, | " | 2.0, | " | 4.5-5.0, | " | 7.0- 8.0 |

The percentage composition of the crude stock has been assumed to be as follows: nitrate of soda 15.5 per cent nitrogen, cottonseed meal 7.2 per cent nitrogen, acid phosphate 14 per cent available phosphoric acid, muriate of potash 50 per cent potash.

Theoretically there may be 27 combinations made in the manner described each different from the other. Practically, owing to the large amount of material other than nitrogen or phosphoric acid occurring in cottonseed meal and acid phosphate, goods containing 3 per cent of nitrogen, 9.3 per cent available phosphoric acid and 2 or more per cent of potash cannot be made from these materials. Recourse must be had in such cases to richer ammoniates (dried blood, flesh meal, etc.) or higher grade phosphates (dissolved bone black, concentrated phosphate, etc.)

Mixtures in which cottonseed meal is used to any extent have as a rule a peculiar sandy color, caused by the yellow hue of the meal. They are quite unlike in appearance to any mixed brand now on sale in this state. Attention is called to the statements regarding the cheapness of nitrogen in cottonseed meal on page 119.

Hen manure is often used in a sort of hybrid home mixture compost. This material often works in nicely in this manner. It should not be composted with lime or ashes as is frequently the custom on Vermont farms, as this serves to drive off a large share of the nitrogen and to lessen its efficiency. Plaster or acid phosphate do not injure it and are to be preferred.

FORMULAS FOR HOME MIXTURES OF ALL GRADES.

| Relative amount in formula of | | | Pounds in a ton | | | | | Approximate percentage composition. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen | Available Phosphoric Acid | Potash | Nitrate of Soda | Cottonseed Meal | Acid Phosphate | Muriate of Potash | Filler | Nitrogen | Available Phosphoric Acid | Potash |
| Low......... | Low......... | Low......... | 60 | 280 | 850 | 80 | 730 | 1.5 | 6. | 2. |
| Medium .. | “ | “ | 100 | 480 | 850 | 80 | 490 | 2.5 | 6. | 2. |
| High ...... | “ | “ | 170 | 750 | 850 | 80 | 150 | 4. | 6. | 2. |
| Low......... | “ | Medium .. | 60 | 280 | 850 | 200 | 610 | 1.5 | 6. | 5. |
| Medium .. | “ | “ | 100 | 480 | 850 | 200 | 370 | 2.5 | 6. | 5. |
| High ...... | “ | “ | 170 | 750 | 850 | 200 | 30 | 4. | 6. | 5. |
| Low......... | “ | High ...... | 60 | 280 | 850 | 320 | 490 | 1.5 | 6. | 8. |
| Medium .. | “ | “ | 100 | 480 | 850 | 320 | 250 | 2.5 | 6. | 8. |
| High ...... | “ | “ | 170 | 710 | 810 | 310 | ...... | 3.9 | 5.7 | 7.8 |
| Low......... | Medium .. | Low......... | 60 | 280 | 1200 | 80 | 380 | 1.5 | 8.4 | 2. |
| Medium .. | “ | “ | 100 | 480 | 1200 | 80 | 140 | 2.5 | 8.4 | 2. |
| High ...... | “ | “ | 150 | 670 | 1100 | 80 | ...... | 3.6 | 7.7 | 2. |
| Low......... | “ | Medium .. | 60 | 280 | 1200 | 200 | 260 | 1.5 | 8.4 | 5. |
| Medium .. | “ | “ | 100 | 480 | 1200 | 200 | 20 | 2.5 | 8.4 | 5. |
| High ...... | “ | “ | 150 | 550 | 1100 | 200 | ...... | 3.2 | 7.7 | 5. |
| Low......... | “ | High ...... | 60 | 280 | 1200 | 320 | 140 | 1.5 | 8.4 | 8. |
| Medium .. | “ | “ | 100 | 430 | 1150 | 320 | ...... | 2.3 | 8.1 | 8. |
| High ...... | “ | “ | 140 | 530 | 1050 | 280 | ...... | 3. | 7.4 | 7. |
| Low......... | High ...... | Low......... | 60 | 280 | 1550 | 80 | 30 | 1.5 | 11. | 2. |
| Medium .. | “ | “ | 80 | 410 | 1430 | 80 | ...... | 2.1 | 10. | 2. |
| Low......... | “ | Medium .. | 60 | 240 | 1500 | 200 | ...... | 1.3 | 10.5 | 5. |
| Medium .. | “ | “ | 80 | 390 | 1350 | 180 | ...... | 2. | 9.5 | 4.5 |
| Low......... | “ | High ...... | 50 | 230 | 1420 | 300 | ...... | 1.2 | 9.9 | 7.5 |
| Medium .. | “ | “ | 80 | 320 | 1320 | 280 | ...... | 1.8 | 9.3 | 7. |

It may not be amiss to describe briefly the process of home mixing. A tight barn floor, platform scales, screen, shovel and hoe comprise the outfit. The materials being weighed, screened and lumps pulverized, the most bulky goods (usually the acid phosphate) are spread in an oblong pile from 6 to 12 inches deep. Upon its leveled top are placed one above another the other ingredients, the resulting pile resembling a layer cake. The pile is then mixed by careful shovelling, the shovel cutting down through all layers each time. The pile is then leveled again and the operation thrice repeated. The mixture may then be screened again if desired.

At present prices for crude stock and for mixed goods the intelligent farmer who uses a ton or more yearly, by buying and mixing nitrate of soda, cottonseed meal, acid phosphate and muriate of potash, can save money and be assured of as good a fertilizer as can be made. The station stands ever ready to aid and advise inquirers on this as well as on any matter connected with agriculture.

## 2. CRUDE STOCK.

Analyses of and comments upon various kinds of raw materials sold in the state are grouped on the next few pages. The user of commercial fertilizers is urged to study them, to familiarize himself with the various materials, and, as has been aptly said by an agricultural writer, to think in terms of nitrogen, available phosphoric acid and potash rather than of phosphate and guano.

### (*a*.) MATERIALS FURNISHING NITROGEN

#### NITRATE OF SODA

| Station Number | Bought of | Sent by or drawn from | Nitrogen |
|---|---|---|---|
| 5584 | ................. | E. S. Brigham, St. Albans | 16.07 |
| 5593 | ................. | E. Hitchcock, Pittsford | 16.03 |
| 5603 | Bowker | L. J. Sanderson, Highgate | 14.87 |
| 5611 | Bowker | G. C. Hubbard, Springfield | 14.76 |
| 6023 | Quinnipiac | G. O. Kelton, Rutland | 15.62 |
| 5957 | Bradley | E. B. Arbuckle, East Montpelier | 15.44 |
| 6158 | ................. | M. W. Smith, Fairlee | 15.95 |
| 6157 | Reed | W. R. Curtis, Jericho | 15.40 |
| 6156 | Gr. Eastern | Experiment Station, Burlington | 15.44 |
| | | Average | 15.51 |

Nine samples of nitrate of soda ranged in composition from 14.76 per cent nitrogen (a very low figure) to 16.07 per cent, in cost from $40 to $47.50 a ton, delivered in Vermont, and in cost to the pound of nitrogen from 12.8 to 15.4 cents, averaging 14.2 cents.

At the present writing, nitrate of soda is somewhat higher in price owing to complications arising from the war. It is mined in Chili, is shipped by water, and if captured probably would be considered contraband of war because of possible use in the manufacture of explosives. At usual prices, however, it is a cheap and highly desirable form of nitrogen.

### COTTONSEED MEAL

| Station Number | Sent by or drawn from | Nitrogen | Phosphoric Acid | Potash |
|---|---|---|---|---|
| 4454 | A. N. Terrill, Morrisville.................... | 6.73 | 2.97 | 1.80 |
| 4471 | H. E. & D. I. Woodruff, St. Johnsbury.. | 7.55 | 2.97 | 1.80 |
| 6147 | W. R. Curtis, Jericho........................ | 7.22 | 3.50 | 2.07 |
| 4481 | Experiment Station, Burlington........... | 6.73 | 3.00 | 1.75 |
| 4472 | E. T. Ide, Passumpsic......... ............... | 6.58 | 3.09 | 1.68 |
| 4473 | George Shorey, Lyndonville................ | 7.44 | 3.05 | 1.78 |
| 4474 | Tower Bros., Barton.......................... | 7.22 | 3.03 | 1.78 |
| 4475 | C. E. Silsby, West Burke .................... | 7.58 | 3.12 | 1.88 |
| 4476 | E. E. Harris, Morrisville..................... | 6.69 | 2.57 | 1.76 |
| 4477 | H. A. Slayton, Morrisville................... | 7.19 | 3.07 | 1.85 |
| 4478 | Geo. G. Robinson, Woodstock.. ......... | 7.54 | 2.37 | 1.65 |
| 4479 | E. W. Bailey, Montpelier.................... | 7.01 | 2.95 | 1.84 |
|  | Average.................................... | 7.12 | 2.97 | 1.80 |

Twelve samples of cottonseed meal contained from 6.58 to 7.58 per cent nitrogen, from 2.37 to 3.50 per cent phosphoric acid and from 1.65 to 2.07 per cent potash, and sold at from $22 to $23.60 a ton. Allowing 4½ cents a pound for phosphoric acid and potash, the nitrogen cost from 11.5 to 14.3 cents a pound, averaging 12.9 cents a pound.

Vermont farmers seldom think of cottonseed meal as a fertilizer, yet hundreds of thousands of tons are thus used yearly in the south and large quantities even in New England. It is undoubtedly better to feed it to stock in moderate quantities, enriching both ration and manure, thus getting two returns for one expenditure. But where more nitrogen is needed than the manure pile supplies, it is safe to say that at the prices ruling during the past few years, no cheaper source of readily available organic nitrogen has been offered in small quantities in our markets than in cottonseed meal. The schedule of trade values used by this as well as other New England stations allows 14 cents a pound for organic nitrogen at the seaboard. It has cost this year on the average in cottonseed meal delivered in Vermont but 12.9 cents a pound.

### (*b.*) MATERIALS FURNISHING NITROGEN AND PHOSPHORIC ACID

### BONE MEAL, TANKAGE, FISH SCRAP, ETC.

| Station Number | Material. | Bought of | Sent by or drawn from | Mechanical analysis |  | Chemical analysis |  |
|---|---|---|---|---|---|---|---|
|  |  |  |  | Finer than 1-50 inch | Coarser than 1-50 inch | Nitrogen | Total Phosphoric Acid |
| 5595 | Bone Meal |  | E. Hitchcock, Pittsford…… | 52 | 48 | 3.68 | 24.72 |
| 5995 | Bone Meal | Armour………… | Ingalls Bros. Lyndon……. | 61 | 39 | 3.01 | 25.07 |
| 6146 | Bone Meal | Great Eastern …. | Exp. Station, Burlington…. | 42 | 58 | 3.81 | 24.53 |
| 6022 | Bone Meal | Quinnipiac……… | G. O. Kelton, Rutland……. | 67 | 33 | 2.06 | 17.00 |
| 5867 | Bone Meal | Pacific Guano Co .. | C. W. Coffran, Lyndonville.. | 67 | 33 | 1.81 | 17.00 |
| 6111 | Bone Meal | Bowker………… | E. W. Barrows, Dorset……. | 40 | 60 | 2.78 | 23.70 |
| 5580 | Tankage.. | Rob'tson & Shiland | P. Lavalle, Williston……… |  |  | 3.83 | 4.26 |
| 5586 | Tankage.. |  | E. S. Brigham, St. Albans… |  |  | 9.56 | 3.93 |
| 5591 | Tankage.. |  | E. Hitchcock, Pittsford…… |  |  | 7.91 | 6.83 |
| 5601 | Tankage.. | Bowker………… | L. J. Sanderson. Highgate.. |  |  | 7.49 | 9.60 |
| 6145 | Tankage.. | Great Eastern….. | Exp Station, Burlington…. |  |  | 7.63 | 9.50 |
| 5613 | Fish Scrap |  | Geo. Aitken, Woodstock…. |  |  | 7.52 | 12.69 |
| 5978 | Fish Scrap | Russia Cement Co. | R, C. Martin, Bradford…… |  |  | 7.75 | 16.49 |
| 6160 | Basic Slag | Troy Iron Works.. | Geo. Cassie, Barre………… |  |  |  | 15.26 |

*Bone Meal* as now sold is usually the residue left after the extraction of a large part of the nitrogenous matter in the form of glue. Raw bone meals are found but occasionally in the trade of this state. Pure raw bone meal (unless fresh or moist when ground) seldom contains much less than 4 per cent nitrogen or much more than 26 per cent total phosphoric acid.

*Tankage* is the dried and ground residue left after meat scrap, bone, tendons, entrails, in short the refuse of slaughter houses, are rendered and the fat removed. It is of variable composition according to the preponderance of meal or of bone. No. 5580 is of low grade, of local manufacture and hardly a tankage in the proper sense of the term.

*Fish Scrap* is the dried and ground residue left after expressing the oil from the menhaden or "porgy" fish. It is comprised of flesh, skin, bones, etc.

*Basic Slag* is a by product of the basic Bessemer steel process. The sample analyzed is of rather low grade.

Six samples of bone meal varied from 1.81 to 3.81 per cent of nitrogen, and from 17 to 25.07 per cent total phosphoric acid. None of them purport to be raw bone. Selling prices ranged from $25 to $33 and valuations from $17.51 to $27.29. In one case 99 cents worth, in another but 63 cents worth of plant food was bought for a dollar.

Five samples of tankage varied from 3.83 to 9.56 per cent nitrogen and from 3.93 to 14.26 per cent total phosphoric acid. Selling prices ranged from $20.00 to $29.30. No mechanical analyses were made and valuation cannot be stated.

One of the fish scraps was bought in carload lot at a price which delivered 121 cents of plant food for a dollar.

### (c) MATERIALS FURNISHING AVAILABLE PHOSPHORIC ACID

### ACID PHOSPHATE, ETC.

| Station Number | Bought of | Sent by or drawn from | Phosphoric Acid | | | | |
|---|---|---|---|---|---|---|---|
| | | | Soluble | Reverted | Insoluble | Total | Available |
| *5583 | ................ | E. S. Brigham, St. Albans..... | 15.29 | 2.91 | 0.18 | 18.38 | 18.20 |
| 5590 | ................ | E. Hitchcock, Pittsford........ | 7.39 | 5.84 | 0.83 | 14.06 | 13.23 |
| 5602 | Bowker ...... | L. J. Sanderson, Highgate ... | 3.20 | 10.25 | 3.29 | 16.74 | 13.40 |
| †5609 | " ...... | G. C. Hubbard, Springfield... | ...... | ...... | 1.85 | 44.02 | 42.17 |
| 6151 | ................ | M. W. Smith, Fairlee........... | 12.51 | 2.25 | 0.52 | 15.28 | 14.76 |
| 6150 | Gr. Eastern.. | Geo. Dow, Cabot,<br>W. M. Mitchell, Mt. Holly | 8.65 | 5.24 | 2.33 | 16.21 | 13.89 |
| 5982 | Bowker ...... | L. F. Fortney, Plainfield...... | 11.88 | 3.02 | 0.48 | 15.38 | 14.90 |
| *5958 | Bradley ...... | E. B. Arbuckle, E. Montpelier | 13.39 | 3.64 | 0.69 | 17.71 | 17.03 |
| 6149 | Read ........... | W. R. Curtis, Jericho Center | 11.82 | 3.16 | 1.64 | 16.62 | 14.98 |
| 6148 | Gr. Eastern.. | Exp. Station, Burlington..... | 8.54 | 5.64 | 2.13 | 16.31 | 14.18 |

For several years available phosphoric acid has ruled cheaper as acid phosphate (dissolved South Carolina or Florida rock) than in the form of dissolved bone black, yet is thought to possess as much agricultural value in the former as in the latter form. Twelve quotations on ton lots delivered at Vermont depots averaged 6.1 cents and 6.7 cents per pound of available phosphoric acid in acid phosphate and in dissolved bone black respectively. The former figure is equivalent to about 4.7 cents f. o. b. seaboard points. The range of acid phosphate quotations is from 5.8 to 6.7 cents, of bone black from 6.2 to 7.0 cents.

Seven acid phosphates ranged from 13.23 to 14.98 per cent available phosphoric acid, while 2 dissolved bone blacks contained 17.03 and 18.20 per cent. They cost delivered from $14 to $17.50 for acid phosphate, and $21.50 for bone black. A pound of available phosphoric acid in the former cost from 4.6 to 5.8 cents a pound delivered in Vermont averaging 5.4 cents, while that in bone black cost 5.9 and 6.2 cents. Available phosphoric acid in acid phosphate has been offered in lower New England and in the Middle States as low as 4 cents a pound and has been bought during the past year at points having water freight, in large lots for cash and upon competitive bidding at but little over 3 cents.

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* Dissolved bone black.

† Concentrated phosphate made from phosphate rock or bone black dissolved with phosphoric acid.

### (*d*) MATERIALS FURNISHING POTASH.

#### POTASH SALTS.

| Station Number | Material | Bought of | Sent by or drawn from | Potash |
|---|---|---|---|---|
| 5585 | Muriate... | .................. | E. S. Brigham, St. Albans .............. | 51.39 |
| 5592 | " | .................. | E. Hitchcock, Pittsford.................. | 51.22 |
| 5600 | " | Bowker....... | L. J. Sanderson, Highgate ............. | 50.70 |
| 5610 | " | " ....... | G. C. Hubbard, Springfield...... ...... | 50.80 |
| 5888 | " | P. G. Co...... | C. W. Coffran, Lyndonville............ | 47.70 |
| 6024 | " | Quinnipiac .. | G. O. Kelton, Rutland.................... | 48.13 |
| 5965 | " | Bowker....... | L. F. Fortney, Plainfield................. | 52.10 |
| 5956 | " | Bradley....... | E. B. Arbuckle, E. Montpelier.. ...... | 50.40 |
| 6153 | " | Gr. Eastern.. | Experiment Station, Burlington...... | 49.70 |
| 6152 | " | Reed.......... | W. R. Curtis, Jericho..................... | 53.05 |
| 6154 | " | .................. | M. W. Smith, Fairlee..................... | 49.60 |
| 6155 | Sulphate. | .................. | M. W. Smith, Fairlee..................... | 49.75 |
| 5984 | " | Bowker....... | L. F. Fortney, Plainfield................. | 49.70 |
| 5983 | Kainit..... | " ....... | L. F. Fortney, Plainfield................. | 12.70 |
| 5686 | " | Bradley....... | D. Spooner, Randolph.................... | 12.20 |
| 6117 | " | Lister.......... | E. E. Harris, Morrisville................. | 12.02 |
| 5974 | " | Gr. Eastern.. | R. C. Martin, Bradford........ ......... | 11.48 |

Eleven samples of muriate of potash varied in potash from 47.70 to 53.05 per cent, in cost from $40 to $50 a ton, potash costing from 4.1 to 5.2 cents a pound delivered in Vermont, and averaging 4.4 cents.

In the two samples of sulphate, which were almost identical in composition, the potash cost 4.9 cents a pound delivered.

Four samples of kainit varied in potash from 11.48 to 12.70 per cent, in cost from $12.50 to $16 a ton, potash costing from 4.9 to 7 cents a pound delivered, averaging 5.9 cents.

The potash salts are all products of mines located at or near Stassfurt, Germany. The muriate and high grade sulphate are refined and concentrated, while kainit is a crude salt.

For tobacco, sugar-beets and sometimes for potatoes, one should choose sulphate; for other crops the cheaper muriate is usually as satisfactory. It is doubtful whether the other salts in kainit compensate for the high cost of the potash.

### 3. WOOD ASHES.

| Station Number | Source. | Received from | Soluble Potash | Insoluble Potash | Total Potash | Total Phosphoric Acid | Insoluble matter | Price per ton |
|---|---|---|---|---|---|---|---|---|
| 5563 | Leached | H. H. Hough, Burlington...... | 0.22 | 0.82 | 1.04 | ...... | ...... | ...... |
| 5564 | Canada | T. L. Johnson, Dummer........ | 3.97 | 0.88 | 4.85 | 1.91 | 10.56 | $9.50 |
| 5565 | " | " " ........ | 3.99 | 1.18 | 5.17 | 1.38 | 13.99 | 9.50 |
| 5566 | Vermont | E. A. Smith, Woodstock........ | 6.25 | 0.81 | 7.06 | 2.06 | 11.40 | 8.00 |
| 5567 | " | " " ........ | 6.23 | 1.13 | 7.36 | 1.91 | 13.05 | 8.00 |
| 5568 | " | " " ........ | 7.65 | 1.23 | 8.88 | 1.92 | 4.26 | 8.00 |
| 5569 | " | W. V. Farr, Buck Hollow...... | 3.55 | 0.66 | 4.21 | 2.71 | 10.44 | ...... |
| 5570 | Canada | F. H. Atwood, Westmister Sta. | 4.36 | 1.50 | 5.86 | 1.29 | 10.12 | 10.50 |
| 5571 | Vermont | " " | 3.34 | 1.99 | 5.33 | 2.64 | 10.90 | 10.50 |
| 5572 | Canada | " " | 3.01 | 0.57 | 3.58 | 1.44 | 10.61 | 10.00 |
| 5573 | New H'p. | " " | 4.53 | 1.61 | 6.14 | 2.95 | 17.36 | 11.00 |
| 5574 | Vermont | A. A. Dunklee, So. Vernon..... | 6.16 | 1.07 | 7.23 | 3.22 | 13.21 | 11.00 |
| 5575 | " | " " ..... | 6.30 | 0.78 | 7.08 | 1.86 | 7.79 | 11.00 |
| 5576 | Canada | " " ..... | 5.41 | 0.54 | 5.95 | 1.64 | 6.90 | 9.50 |
| 5577 | " | " " ..... | 4.09 | 1.54 | 5.63 | 1.77 | 10.88 | 9.50 |
| 5578 | " | " " ..... | 5.09 | 0.24 | 5.33 | 1.99 | 11.56 | 9.50 |
| 5579 | " | " " ..... | 4.08 | 0.57 | 4.65 | 1.92 | 11.75 | 9.50 |
| 5594 | Vermont | N. B. Powers, Leicester Junc. | 5.29 | 2.19 | 7.48 | 3.10 | 13.51 | ...... |
| 5596 | " | E. A. Smith, Woodstock........ | 6.90 | 0.84 | 7.74 | 2.90 | 6.50 | 8.00 |
| 5606 | " | H.C.Gorham, Westminster W. | 6.20 | 0.08 | 6.28 | 2.08 | 7.37 | ...... |
| 5607 | " | " " | 8.56 | 0.53 | 9.09 | 3.16 | 10.82 | ...... |
| | | Average (except 5563)........... | 5.25 | 0.99 | 6.24 | 2.19 | 10.65 | ...... |

Twenty samples of wood ashes, said to be unleached, varied from 3.01 to 8.56 per cent soluble potash, 3.58 to 9.09 per cent total potash, 1.29 to 3.22 per cent total phosphoric acid and averaged 5.25, 6.24, and 2.19 per cent in the same ingredients.

Wood ashes are used quite largely on the east side of the state particularly in the Connecticut valley. Considered as a source of potash only they are expensive goods at ruling prices. It should be remembered, however, that the good results often obtained by their use are quite as apt to be due to their mechanical effect upon the soil, or to their lime content, as to the potash they contain. All ashes contain carbonate of lime, which, unless they are seriously adulterated by sand and earth, is usually not so variable in its percentage as is the potash. In 50 of 59 samples reported on by the Connecticut station for the past 3 years the percentages of lime (CaO.) have ranged between 27.3 and 38.8, averaging 33 per cent. If 4½ cents a pound are allowed for soluble potash and for phosphoric acid in average ashes, costing $10 a ton delivered it leaves $3.30 for the lime, or 50 cents a hundred, which is quite an advance on the price for lime in Vermont markets. Hence it may be fairly questioned whether at ruling prices average ashes are as cheap as sources of potash, phosphoric acid and lime as are muriate of potash, acid phosphate and lime.

Attention is called to the very low potash contents of the leached ashes (No. 5563). These goods were quite wet, weighed heavily to the bushel and the price asked was more than half the cost of a good grade of unleached ashes.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 66

SEPTEMBER, 1898

# CLUB-ROOT AND BLACK ROT

## TWO DISEASES OF THE CABBAGE AND TURNIP

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  1. NATURE AND OCCURENCE—Pages 13-15.
  2. REMEDIAL MEASURES—Pages 15-16.

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# BULLETIN NO. 66.

# CLUB-ROOT AND BLACK ROT—TWO DISEASES OF THE CABBAGE AND TURNIP.

By L. R. Jones.

## I. SUMMARY.

**II.** Club-root and black rot, destructive diseases of the cabbage, turnip and allied plants, are threatening to become widespread in Vermont. They are easily suppressed if taken in season. Page 5.

**III.** Club-root is a curious malformation of the roots, which ruins the plants by preventing the absorption of water and foods. It was probably introduced into this country from Europe, and is spreading. It has been observed in Vermont only recently. Pages 5-6.

Clubbing of roots is due to their invasion by a parasite which stimulates them to abnormal growth. This parasite once established in the soil, is very difficult to exterminate. Page 6.

The parasite is perpetuated over winter by spores which are formed in vast numbers in the clubbed roots. Page 7.

These germs pass uninjured into the manure of stock fed upon clubbed roots, and the use of such infected manure is one of the commonest ways of introducing the germs into the soil. Another way is with roots transplanted from infested soil. Page 7-9.

The disease attacks numerous plants of the mustard family, including various common garden vegetables, flowers and weeds. This aids in its spread and perpetuation. It can, however, live a number of years in the soil independently of any host plant. Pages 9-10.

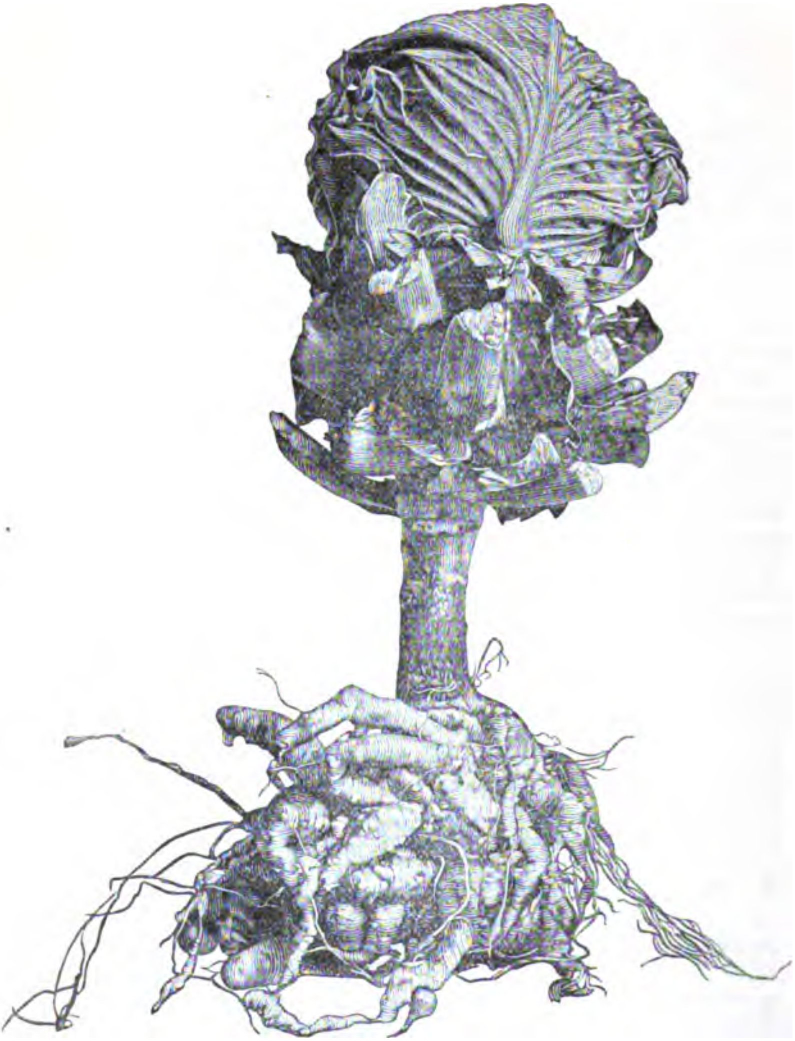
Remedial Measures:—1. Remove all clubbed roots from the field and destroy them by burning or burial, or boil them if to be fed to stock. 2. Plow infected soil deeply. 3. Rotate crops. 4. Suppress all weeds of the mustard family. 5. Apply lime, 75–150 bushels per acre, in autumn before planting cabbages or turnips. Pages 10-12.

**IV.** Black rot of cabbages, etc., a recently recognized disease, has been observed in numerous Vermont fields. Pages 13-14.

It is caused by bacteria. which invade the vessels of leaves and stem. The diseased plants are weakened or die of a sort of dry rot. The blackened condition of the invaded veins is the surest sign of the disease. It is not to be confused with the common wet rot. Pages 14-15.

The germs pass the winter in the soil, or in the manure if diseased plants are fed to stock. They re-enter the cabbage plants through the water pores or insect punctures. Page 15.

Remedial Measures:—1. Rotation of crops. 2. Care in selection of manure. 3. Suppression of cabbage insects. 4. Removal and destruction of spotted leaves in the early stages of the disease and of entire plants if the stem is invaded Pages 15-16.



1. A CABBAGE PLANT SHOWING CLUB-ROOT.

The large outer leaves were cut off in order to reduce the size before photographing.

## II. INTRODUCTION.

The attention of the experiment station has recently been called to two serious diseases of the cabbage, turnip and allied plants, namely, club-root and black rot. It is believed that these maladies are not as yet generally distributed through Vermont although occurring in many places in the state. Inasmuch as both of them can be held in check by inexpensive measures where recognized and promptly dealt with, it is believed that the present bulletin is a timely one. It aims chiefly to warn gardeners of the danger and point out methods of prevention.

## III. CLUB-ROOT.

### 1. NATURE AND OCCURRENCE.

### WHAT IS CLUB-ROOT?

It is one of the most curious of plant maladies, and remained for many years one of the most mysterious alike to the practical cultivator of crops and to the scientific student of their diseases. It occurs most commonly and conspicuously on cabbages and turnips, although it is by no means restricted to these two vegetables. The appearance of badly diseased roots of cabbage is well shown in figure 1, and of turnip in figure 2. Later figures illustrate similar attacks on some other common plants. As clearly shown in these cuts, the roots of the diseased plants are curiously and monstrously deformed. It is this which has given to the malady various graphically descriptive popular names: "club-root" and "club-foot" in America, "finger-and-toes" in England, and "Kohl-hernie" (cabbage-hernia) in Germany.

As a result of their diseased condition clubbed roots are unable longer to perform their functions of supplying the leaves with water and crude foods from the soil. The most conspicuous symptom of the trouble is the resulting wilt of the leaves of diseased plants on hot days. As soon as the roots are badly clubbed such plants begin to fall behind their fellows and either make a sickly growth, leading to a worthless crop, or else die altogether. Since it is a contagious disease and comparatively new to Vermont it may well be asked,

### WHAT IS ITS HISTORY?

In Great Britain it has been known for a century and more as the most troublesome obstacle to the grower of the turnip and cabbage. Its history on the continent of Europe does not date back quite so far. There is little question that it was introduced into America from some European source, as its first appearance here was noted in the eastern United States, whence it is slowly spreading to other parts of the country. It has long been known to the market-gardeners of New York and vicinity but is attracting more and wider attention each year as the damage caused by it there and elsewhere is increasing.

*In Vermont.*—There was an outbreak of club-root upon the old experiment farm soon after the establishment of the station there. This was promptly suppressed, however, and it has given us no trouble since. Rumors of its occurrence in Vermont have reached this station from time to time but in the absence of specimens or more definite information we have remained in doubt as to their authenticity.

In August 1897, a letter came from Mr.G. A. Terrill of Underhill Center stating that his cabbage crop was a failure and that neither he nor others in that vicinity had succeeded in raising cabbages for three years past. Accompanying the letter was a specimen similar to figure 1, which showed the trouble to be club-root.

Personal investigation confirmed Mr. Terrill's report of the very general occurrence of the malady in the vicinity of Underhill Center. It has also been found in a number of places near Burlington and certain observations lead to the belief that it is probably not uncommon in the gardens of this city. Further reports have also come to us during the year of its presence in other parts of the state. Intelligent watchfulness is evidently needed to prevent its very general distribution. The reasons for this latter conclusion will become more evident as its modes of dissemination are discussed.

## WHAT CAUSES CLUB-ROOT ?

These curious malformations of the roots result from their invasion by a parasite* of so low an organization and curious a character that scientists are in doubt whether to call it a plant or an animal. If this organism is once introduced into the soil it is almost impossible to eradicate it totally, as it is capable of developing and of living there, for some years at least, independently of the cabbage or other host plants. Apparently, however, it cannot so live beyond a limited time, perhaps three to five years.

If cabbages, turnips or allied plants are growing in such infested soil the parasite invades their roots. Once inside it grows and multiplies very rapidly until it occupies the root system more or less completely. Such roots are stimulated to the curious abnormal developments shown in figures 1 and 2.

The progress of the disease is so rapid that seedling cabbages grown in infested soil will often be badly clubbed before they are large enough to transplant. Four or five weeks is ample time for the clubbing of every root in a bed.

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* *Plasmodiophora Brassicae* Wor. This is a microscopic organism, larger and more complex than the bacteria, but less so than the true fungi. Its character and causal relation to the clubbing of roots was determined in 1876, by Woronin, a Russian botanist.

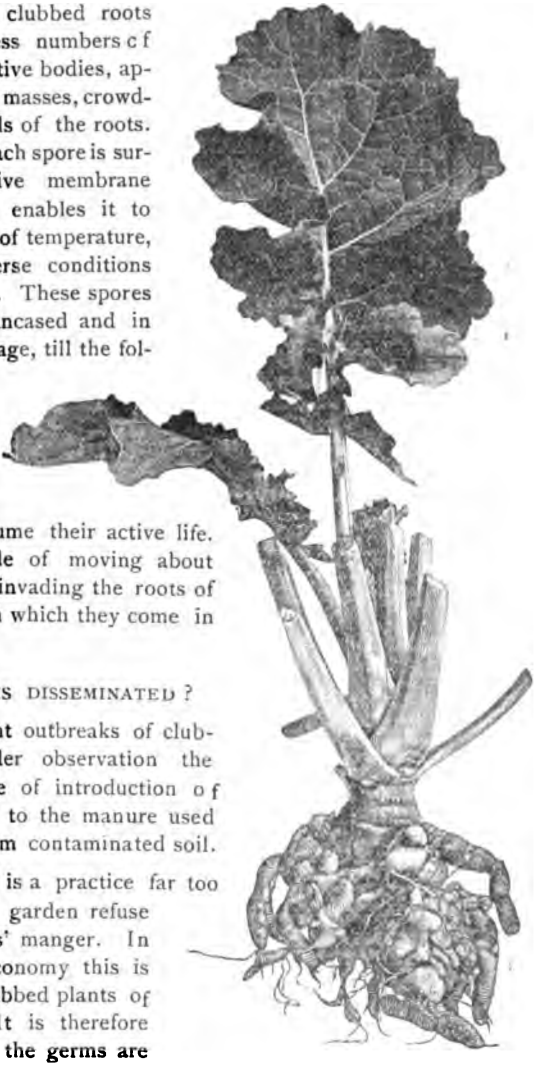
### HOW DO THE GERMS PASS THE WINTER ?

Microscopic examination of the roots sent in by Mr. Terrill in September showed that the parasite had already passed into its winter state or dormant condition, and that the clubbed roots were filled with countless numbers of the spores or reproductive bodies, appearing as tiny spherical masses, crowding all the distorted cells of the roots. During its winter rest each spore is surrounded by a protective membrane which doubtless better enables it to withstand the extremes of temperature, drought and other adverse conditions with which it may meet. These spores normally remain thus incased and in a dormant or resting stage, till the following spring, when, if the clubbed roots containing them are allowed to remain in the soil and decay, they are freed to resume their active life. They are then capable of moving about through the soil and of invading the roots of any new host-plant with which they come in contact.

### HOW ARE THE GERMS DISSEMINATED ?

In all cases of recent outbreaks of club-root which came under observation the past season the source of introduction of the germs was traced to the manure used or to plants brought from contaminated soil.

(*a.*) *In manure.*—It is a practice far too common to throw any garden refuse into the pig-pen or cows' manger. In the course of farm economy this is generally the fate of clubbed plants of cabbage or turnip. It is therefore wise to inquire whether the germs are destroyed by passing through the di-



2. TURNIP SHOWING CLUB-ROOT.

gestive tract of such an animal ? Halsted,* of the New Jersey station, put this question to the test some two years ago by feeding to a heifer a bushel of clubbed turnips and applying the resulting manure to an experimental plot sown with turnips. Every root grown upon the soil thus manured was badly clubbed, whereas the adjoining unmanured plants remained sound.

The practical danger of the use of contaminated manure is shown by the following case. There is a garden immediately adjoining the experiment station office where cabbages and related plants have been grown for years with no trace of club-root. Last spring the owner bought a quantity of city manure from an unknown source and applied it to this soil. Every cabbage and cauliflower grown in that garden this summer was destroyed by club-root, and as the seedling plants were all home-grown, the owner, rightly, we believe, concludes that the germs of the disease were introduced in the manure.

An experience of Mr. Terrill at Underhill Center the past season furnishes further evidence along the same line. Discouraged by the failures of several seasons from again placing turnips or cabbages in his garden, he broke up a piece of grass land upon which to plant these crops. This sod had not been plowed within his memory; moreover, it was situated on a steep hillside where it could receive no drainage waters from any infested soil. To insure a good crop Mr. Terrill gave it a heavy dressing of stable manure. Unfortunately this manure came from stock to which he had the previous autumn fed the diseased roots from his garden. The results were disastrous. Every cabbage and turnip plant grown upon this piece was badly clubbed, and even the seedling cabbages started here and removed to clean soil carried the disease with them and were ruined thereby.

These experiences agree with those of other gardeners with whom we have talked, and show that the clubbed roots should not be fed to stock, or if this is done the resulting manure is to be regarded as filled with the germs and used accordingly. It also shows the danger of buying manure from an unknown source or from animals fed indiscriminately upon garden wastes.

(*b*) *With seedling plants and nursery stock.*—Seedling cabbages which are grown upon infested soil are probably the most common carriers of the germs. These will often become badly diseased before their removal from the seed-bed, but unless the roots are conspicuously deformed they may pass through the hands of an ignorant or unscrupulous dealer and into the gardens of unsuspecting purchasers. Hence the source and condition of cabbage plants bought in the market should be always a matter of inquiry.

Another danger harder to guard against was brought to our attention the past season by the experience of a Burlington gardener. He is one of the leading market-gardeners of the place, and has grown large numbers of cabbages in past years without a trace of the disease. Last July he reported that a portion of the plants on one field of cabbages and cauliflowers were entirely clubbed. Upon visiting the place a puzzling state of affairs was found. The piece of land in question was perhaps 20 rods long by 10 wide. The rows ran east and west, the longer way of the field. Beginning at the north side the plants on about one-half the width of the field were badly clubbed, while the plants of the south half were perfectly healthy. How could this be explained? Both the grower and the writer puzzled over the matter for a time. All the plants in the field were home-grown and from the same seedbed. The entire field had been manured alike. No cabbages, turnips or related plants had been grown on this soil for years and no club-root had ever been seen on the place. Tracing the possible sources of infection back year by year, it suddenly occurred to the owner that in 1895, three years before, he had grown celery on the entire piece. In setting it out he had used his home-grown seedlings on most of the field but running short of these he had bought enough from a grower in the lower Hudson valley to fill out the piece. Upon measurement he found that the area now showing clubbed roots coincided very closely with the area upon which those purchased celery plants were put. The region from which these plants came is very generally infested with the club-root and there seems abundant reason for believing that the germs were brought into the soil upon the roots of these celery plants. The proof of course lacks positiveness, but there is no doubt that enough soil is carried on such roots, in the process of transplanting, to thoroughly stock the soil in which they are set. When one realizes this and considers the general traffic and exchange in nursery stock, the wonder is that the germ is not more widely introduced than is the case.

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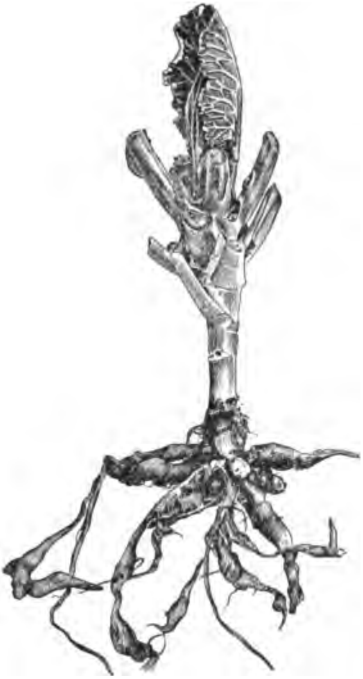
*N. J. Exp. Sta., Rpt. 17 (1896), p. 307.


3. YOUNG CAULIFLOWER WITH CLUBBED ROOTS.

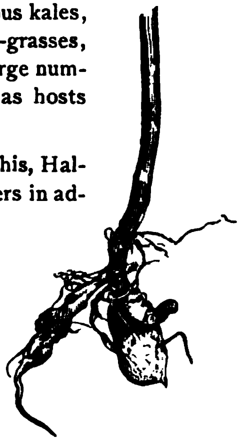
WHAT PLANTS ARE ATTACKED?

So far, mention has been made of three common garden vegetables which are liable to the club-root, namely cabbage, cauliflower and turnip. These are all members of the mustard family. This family is a large one and its members show close relationship. It includes the various kales, mustards, shepherd's purse, radish, cresses, pepper-grasses, sweet alyssum, etc. It is important to note that a large number of the plants of this numerous family may serve as hosts of the club-root parasite.

In order to gain more exact information regarding this, Halsted* grew those already mentioned and various others in addition upon soil containing the club-root germs. He found the following among the kinds to become clubbed:

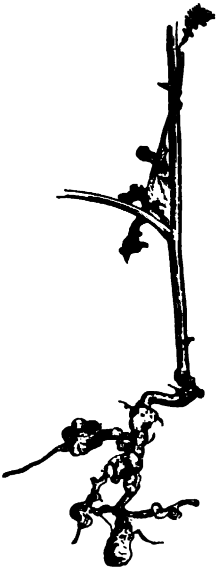
*Vegetables.*—Cabbage, cauliflower, brussels sprouts, garden kale, turnip, ruta-baga, white mustard, radish.

*Flowers.*—Candy-tuft, sweet alyssum. Clubbing has also been observed on the garden stock in Russia.



4. CLUB-ROOT OF COMMON "KALE."

*Weeds.*—Shepherd's purse, wild pepper-grass, penny cress, black mustard, hedge mustard, wild kale, charlock, false flax.



5. HEDGE MUSTARD WITH CLUBBED ROOTS.

HOW LONG WILL THE GERMS LIVE IN THE SOIL?

It is a matter of much practical importance to know how long the germs of club-root live in the soil if no cruciferous plants are grown upon it. In other words how long will it take to "starve them out"?

Potter,† an English botanist, is conducting some experiments to determine this. He has found that they persist at least two years in soil upon which no host plant is allowed to grow, and it is probable that they will do so considerably longer. Halsted's‡ experiments have led him to similar conclusions.

2. REMEDIAL MEASURES.

*Destruction of the germs in the clubbed roots.*—The danger from feeding clubbed roots to stock or from throwing them into the compost pile has already been explained. It is equally clear that they should not be allowed to remain to decay on the surface of the soil. What, then, shall be done with them? If there are only a few roots they may be burned. If the quantity precludes burning they may be buried or cooked. Halsted boiled diseased roots three hours and found all germs destroyed. Such cooked plants may safely be fed to stock, and probably a much shorter period of boiling would suffice to destroy the parasite.

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*N. J. Exp. Sta., Rpt. 17 (1896), p. 309.

†Potter, Jour. Newcastle (Eng.) Farmers' Club, 1896.

‡N. J. Exp. Sta., Rpt. 17 (1896), p. 308.

Potter found that when the germs were buried in the soil six inches or deeper they soon perished. It is inferred, therefore, that deep burial in soil where there is no drainage outlet is a safe way to dispose of clubbed roots.

*Deep plowing.*—Potter's results also emphasize the importance of very deep plowing of infested soil. This should be done in the autumn, the object being to bury all the germs at least six inches deep. It is, of course, impossible in practice to completely accomplish this result, but deep plowing is advised in connection with the use of lime as recommended below.

*Rotation of crops.*—The importance of this is already evident. Infested soil should be heavily seeded to grass or, for a number of years at least, planted to crops which do not serve as hosts for the club-root. It is said* that in Scotland where turnips are necessary in all crop rotations, "a four year rotation does not give complete exemption from this disease, neither is five years considered quite a safe interval, but seven years is." A list of cultivated plants which should be excluded from the land during this interval is given on the opposite page.

*The suppression of cruciferous weeds.*—The farm laborer who weeded one large cabbage field under observation the past summer said that he had found every kale plant growing in that field to be clubbed. It is evident that infested soil should be kept entirely free from kale, wild mustard, shepherd's purse and the related weeds mentioned on the opposite page.

*Lime.*—The best practical measure for the prevention of club-root in soil that contains the germs is the liberal application of lime.

Halsted,† after several years experimentation at the New Jersey station, advises that from 75 to 150 bushels per acre of air-slaked lime be applied broadcast in the autumn. This should lie on the surface over winter and be worked thoroughly into the soil in the spring before planting.

The importance of applying the lime some months before planting was clearly shown in his experiments. Thus, in 1893, the crops on a certain field were badly clubbed. On April 24, 1894, lime was applied in amounts varying, on different plots, from 37½ to 150 bushels per acre. May 2, six days later, turnips were sown and cabbage plants set there. The results showed that the lime had not time to act as some of the roots were clubbed even on the heavily limed soil. These plants were removed, the application of lime repeated and second crops of both turnips and cabbages started on the same plots August 10. These also showed some clubbing, but not enough to seriously injure the crop. Two crops of cabbages and turnips have been grown on this soil each of the three seasons since without serious loss from club-root, although the dressings of lime have not been repeated.

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*Tubeuf and Smith, Diseases of Plants, p. 527.

†N. J. Exp. Sta., Rpt. 17 (1896), p. 306.

Halsted found, however, that where he used more than 150 bushels of lime per acre the crops of the first two years, at least, were somewhat injured. On the other hand 75 bushels per acre prevented the clubbing as effectually as did the heavier amounts.

Last April Mr. Terrill, of Underhill Center, kindly offered to test the value of lime experimentally upon his ground. Profiting by Halsted's results we did not hope to prevent the disease entirely by an application made in the spring. About May 1, stone lime was scattered over the soil at the rate of 80 bushels per acre (½ bushel per square rod). As soon as this had air-slaked it was thoroughly worked into the surface soil. Cabbages were planted and turnip seed sown on the piece about June 1. The cabbage plants used came from two sources, (1) those grown on Mr. Terrill's infested soil, and (2) plants sent him by the station from clean soil. The plan of the experiment is shown in the following diagram:

MR. TERRILL'S EXPERIMENT.

| | |
|---|---|
| I. TURNIPS. | |
| (a) limed. | (b) not limed. |
| II. CABBAGES FROM INFESTED SOIL. | |
| (a) limed. | (b) not limed. |
| III. CABBAGES FROM CLEAN SOIL. | |
| (a) limed. | (b) not limed, |

The crops have not been harvested at the time of writing, but the general results are very evident. On I (b) every turnip is clubbed and undersized; on I (a) there is evidently some clubbing but less than on (b), and the roots are much larger and the leaves show greater vigor.

On II every plant was so badly clubbed that not a head has formed either on (a) or (b).

On III (b) the same condition exists, while III (a) is in striking contrast, as here most of the plants are vigorous and fully 60 per cent of them have formed good heads.

Mr. Terrill expects to continue the experiment by repeating the application of lime this autumn, and he hopes to raise a still better crop of cabbages on the same piece next season.

## IV. BLACK ROT.

### 1. NATURE AND OCCURRENCE.

#### OCCURRENCE.

This disease has been recognized only recently, but is apparently widespread in Vermont and on the increase. The first definite publication regarding it came from the Kentucky Experiment Station in 1890. It was there described as seriously injuring cabbages. It was next reported from the Iowa station as causing a destructive rot of turnips. During the past few years it has led to serious loss, especially of cabbages, in southern Wisconsin, Michigan, New York, Maryland and elsewhere.* It was first recognized in our experiment station garden in 1897, although it may have occurred there earlier. Systematic examination of the gardens about here the present season has shown its presence in numerous places. Specimens have been received also from the Connecticut valley with reports of serious damage. Its occurrence at other points in the state has been noted, but it has

6. BLACK ROT. NOT A SINGLE HEAD HARVESTED FROM THE FIELD.†

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*The disease has received most careful study by Russell and Harding, of the Wisconsin experiment station, and by Smith, of the U. S. Dept. Agr. Any one wishing detailed information regarding it should secure the following bulletins, upon which the present account is largely based:

U. S. Dept. Agr., Washington, D. C., Farmers' Bul. 68.

Wis. Exp. Sta., Madison, Wis., Bul. 65.

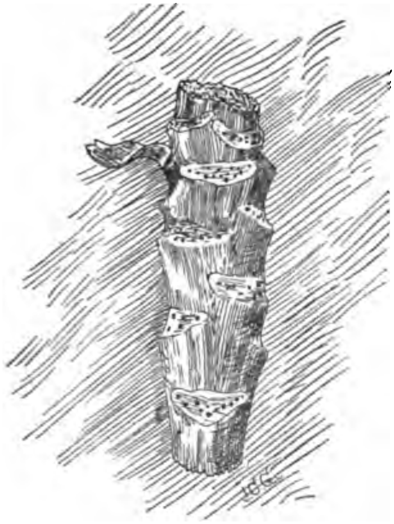
†From photograph of a Wisconsin field. Figures 6, 7, 8 and 9, are kindly loaned by the Wisconsin station.

nowhere excited great apprehension. All gardeners consulted agree in the opinion that the trouble is a recent thing.*

It has been observed in Vermont upon cabbages, cauliflower and turnip only, but it is known to attack other related plants, including the kales and wild mustards.

SYMPTOMS AND CAUSE.

As observed upon the cabbage and cauliflower the first indication of the disease is upon the outer leaves of the plant, which turn yellow and die in spots, usually at or near the margin. Such leaves are also liable to wilt. Careful examination shows that the veins in the dead areas are blackened (Fig. 9) These spots enlarge, following down the veins toward the stem. The disease upon reaching the stem may pass up or down it and into other leaves, and once established there it rapidly spreads thus through the entire plant.



7. DISEASED CABBAGE STEM.

Showing the black spots in the leaf scars. These spots are a sure sign of the black rot showing that the germs have already passed from the leaves into the stem.

The germs which are the cause of the malady spread exclusively through the vessels or fibrous portions of the tissue. These invaded vessels turn black and this striking discoloration is a valuable diagnostic feature of the disease which every cabbage grower should learn to recognize. (Fig. 7.) If the stem of a healthy cabbage leaf be cut across these vessels are seen forming faint yellowish spots in the interior, in marked contrast to the black spots seen in the badly diseased leaf. In case of leaves which are but partly diseased only those vessels leading into the diseased areas will become blackened. Anyone seeing suspicious looking leaves on his cabbage plants may, therefore, readily satisfy himself as to whether it is this black rot by cutting off the dying leaf stems and examining their freshly cut surface for these black dots.

---

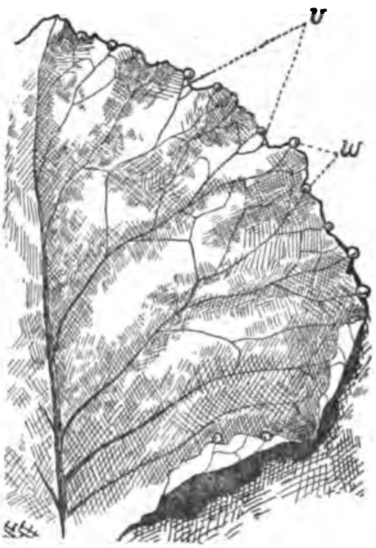
*Cabbage plants may die and decay from other causes than the one here discussed. The common "wet rot" of the cabbage tissues, which converts them into a slimy mass and is characterised by the very offensive odor, is apparently not a specific parasitic disease. This wet rot attacks cabbage tissues whenever they are killed by any agency. It often accompanies the black-rot and hastens the destruction of the plant.

If it proves to be this malady prompt measures should be taken to prevent its spread,* and also to lessen the chance of the permanent establishment of the germs in the soil. In order to do this intelligently one should understand how the disease spreads.

### MODE OF SPREAD.

If the leaves of a vigorous cabbage in moist soil be examined in the early morning tiny drops of water will often be found borne upon the margin of the leaves. (Fig. 8.) These water-beads have exuded from the interior of the leaf through the pores which are exceptionally large at these points. The germs most commonly find entrance into the leaf by lodging in one of these water-beads and thence passing through the pores into the veinlets. In addition they are doubtless often introduced and spread by cabbage-eating insects which pass from the diseased to the healthy leaves. (Fig. 9.)

If rotting cabbage plants are left in the field the germs pass the winter in the soil and re-infect cabbages, turnips or weed-plants which may grow thereon the next season.



8. A HEALTHY CABBAGE LEAF. Showing water-beads along the margin. (w, etc.) The germs readily pass from these into the veinlets. (v.) Compare with fig. 9.

If fed to stock they pass into the manure and are similarly propagated in that way.

### 2. REMEDIAL MEASURES.

Consideration of the above facts shows the need of the following preventive or remedial measures where the disease is observed:

*Rotation of crops.*—Cabbages or turnips should not be planted a second year upon land where the disease is observed. In view of the dangers from this disease and club-root it is better in any case to rotate these crops with others. The seed-bed also should be made in new soil each year.

---

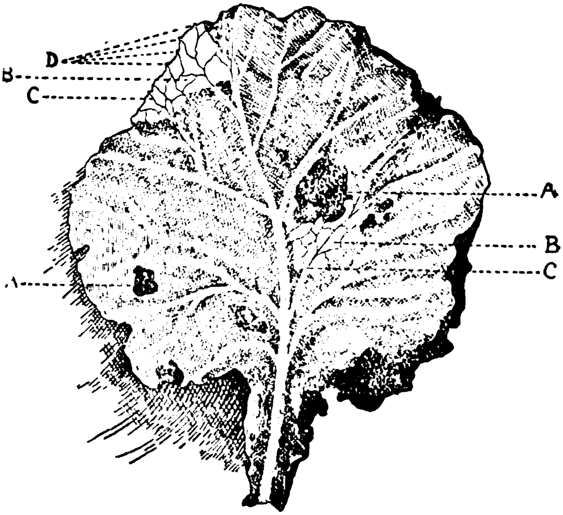
*Serious rotting in the storage cellar is certain to follow where cabbages containing this germ are not excluded. The Burlington grocers are complaining of an unprecedented loss from this rot in early cabbages handled by them the present season. In selecting cabbages for storage examine the outer leaves and especially the freshly cut stem for the blackened veins, and lay out for immediate consumption any showing even the slightest races of the disease.

*Fertilization*.—Diseased cabbages should never be fed to animals uncooked. Manure from animals fed on garden refuse should not be used on soil intended for cabbages.

*Destruction of insects*.—Keep the plants as free as possible from insects.

*Removal of diseased leaves and plants*.—Where the disease has once appeared, the cabbage field should be watched and during August and September should be systematically gone over and all leaves removed and destroyed as soon as they show evidence of the disease. In case the germs have invaded the stem (as shown by the blackened vessels at the junction of diseased leaf and stem) the entire plant should be uprooted and destroyed. This destruction should be by fire or deep burial.

*Suppression of cruciferous weeds*.—No plants of kale, wild mustard or other related weed which may harbor the disease should be allowed to grow in or near the cabbage field.



9. A LEAF IN THE EARLY STAGE OF THE ROT.

Showing manner of infection. The disease has invaded two areas which are left white in the figure (B and B), with the veins blackened, (C and C.) In one case the germs entered through the water-pores, (D), in the other along the margins of the hole eaten by insects. (A.)

# Vermont Agricultural Experiment Station.

# SPRAY CALENDAR.

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## THE BEST INSECTICIDES AND FUNGICIDES.

(Liquid mixtures are best applied with a force pump having a fine spray nozzle.)

| | |
|---|---|
| **For insects that chew (beetles, worms, etc.)** | *a.* *Paris green.* If applied dry, best dilute with land plaster or similar powder. If water is used, mix at rate of ¼ to ½ pound of poison with equal weight of freshly slaked lime and dilute with 1 bbl.(45 gallons)of water.<br>*b.* *Hellebore.* Apply dry, or in water (1 ounce in 3 gallons.) |
| **For insects that suck, (lice,scales,etc.)** | c. *Kerosene emulsion.* Dissolve ½ pound hard soap in 1 gallon boiling water, add 1 gallon kerosene, churn with spray pump 5 to 10 minutes, (until permanently mixed.) Dilute with 5 to 20 parts of water before using. Kills by *contact* only. |
| **For fungi, (blight,rot,rust, etc.)** | *d.* *Copper sulphate.* Dissolve in water at rate of 1 pound to 15 gallons.<br>*e.* *Bordeaux mixture.* 1½ pounds copper sulphate, 1 pound fresh lime, 10 gallons water. Dissolve the sulphate and slake the lime in separate vessels; dilute each with about one-half of the total water to be used, then pour the sulphate solution into the lime water while stirring vigorously and continue the stirring until very thorougly mixed. |
| **For insects and fungi.** | *f.* *Paris green* added to *Bordeaux mixture* at rate of ¼ to ½ pound of Paris green per barrel of mixture. |

## THE MOST COMMON DISEASES AND BEST PREVENTIVE MEASURES.

(In the following the italicized letters refer to the above remedies. Directions inclosed in parentheses are relatively less important.)

APPLE AND PEAR. *Codling Moth* (Core Worm) and all leaf-eating insects: Apply *a*, (*first*, just before the blossoms open); *second*, as soon as the blossoms fall; (*third*, about two weeks later.)

*Apple Maggot* (Railroad Worm): Keep pigs or other stock in the orchard so as to eat all fallen fruit.

*Black Scab*: Apply *d* before leaf buds open, later apply *f* three or more times at dates given for codling moth.

*Fire Blight*: Cut off promptly and burn all blighting limbs.

CHERRY AND PLUM. *Plum Scale*: Apply *c* (diluted 5 times) in autumn after leaves have fallen and again in Spring before buds start.

*Curculio*: Jar the insects into a blanket. (Spray with *a*.)

*Brown Rot*: Promptly gather and destroy all rotting fruit. Apply *d* in spring before buds start and follow with *e* at intervals until fruit is nearly ripe.

*Black Knot*: Cut off and burn knots as soon as seen. (Spray as for Brown Rot during spring.)

CABBAGE. *Worm*: If before heads are forming apply *a* or *c*; after heading use *b* or hot water.

CURRANT. *Worm*: Apply *a* as soon as leaves expand; 10-14 days later apply *b*, and repeat as needed.

POTATO. *Beetles*: Apply *a* in earlier part of summer.

*Blight, Rot and Insects*: Apply *f* or *e*, beginning at date varying from July 1 on earlier potatoes to August 1 on late ones, and repeating every 10 to 20 days until maturity.

RASPBERRY AND BLACKBERRY. *Orange Rust* of leaves: Dig out and burn diseased plants at once.

*Anthracnose* or "Cane Rust:" Cut out and burn diseased canes and spray with *d* in spring before buds burst, follow with *e* until fruit is formed.

STRAWBERRY. *Leaf Spot* or "Rust:" Apply *e* in early spring, repeat once as first fruits are setting and again after the harvest.

**Write for more detailed information concerning these or other plant diseases. Insects or fungi injurious to plants identified on request, also weeds, grasses, or other plants.**

**Address EXPERIMENT STATION,**
**Burlington, Vt.**

March, 1897.

(See Law regarding spraying fruit trees on other side.)

# The New Law Regulating the Spraying of Fruit Trees.

Many inquiries have been made respecting both the nature of the law recently passed in this State regulating the time of spraying fruit trees and the results to fruit growers of its enforcement. The text of this law is given below followed by brief statements as to its object, and the conclusions of experts as to the proper time of spraying in order to secure the best results.

## OBJECTS OF THE LAW.

The law was passed at the request of the Vermont Bee-Keepers Association, in order to prevent the danger of poisoning honey-bees visiting trees which were sprayed while in blossom. It is impossible to say just how great is the danger thus apprehended by bee-keepers. There is, however, reliable experimental evidence showing that bees have been fatally poisoned in such manner, and it seems possible if not probable that the use of poisonous sprays upon fruit trees while in blossom would be a serious injury to the bee-keeping industry.

## THE LAW.

AN ACT TO PREVENT THE USE OF POISONOUS SUBSTANCES UPON FRUIT TREES IN BLOSSOM.

It is hereby enacted by the General Assembly of the State of Vermont:

Section 1. If a person sprays or causes to be sprayed, or puts or causes to be put, any Paris Green, London Purple or other poisonous substance upon fruit trees while in blossom, he shall be fined not more than forty dollars and not less than ten dollars.

Sec. 2. This act shall take effect from its passage.

Approved November 20, 1896.

## HOW DOES THE LAW AFFECT FRUIT GROWERS.

Is it necessary or desirable from the fruit growers' standpoint to spray when the trees are in blossom? If so the law might prove injurious to one industry while favoring another. This matter has been carefully investigated at various times by Experiment Station workers and other experts throughout the country, and their unanimous verdict is that *it is not necessary to spray fruit trees when in blossom in order to give them practical protection against insects and fungus attacks.* In accord with this verdict the unanimous advice of Experiment Station bulletins in all the States has been that fruit trees be sprayed either *before* the blossoms open or *after* they fall and not during the blossoming period. The leading orchardists in the country at the present time are following this advice with satisfactory results. Spraying trees when in blossom would be attended with possible danger of loss to the fruit grower himself as well as to the bee keeper, since the poisoning of the blossoms might interfere with their proper fertilization and with the consequent setting of fruit.

Bees do not injure flowers or fruit, but on the other hand are helpful to the orchardist since they aid in carrying pollen from blossom to blossom and thus insuring proper fertilization of the flowers.

No well informed fruit grower therefore who is consulting his own interests would spray when the trees are in blossom, even if the present law were not enforced.

L. R. JONES, Botanist, Vermont Experiment Station.

March, 1897.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

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VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 67

DECEMBER, 1898

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## HYBRID PLUMS

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# THE VERMONT

# Agricultural Experiment Station,

## BURLINGTON, VT.

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# BULLETIN No. 67.—HYBRID PLUMS.

BY F. A. WAUGH.

## I. SUMMARY.

**II. 1. Descriptive and historical notes are given of fifty varieties of plums which have been supposed to be of hybrid origin. A few of these are doubtless not hybrids, though the large majority probably are. Pages 5-22.**

**2. There are also certain large groups of plums growing wild in North America which seem to be of hybrid origin, the most important being the Wildgoose, Wayland and Miner groups. Even under cultivation hybrids seem to occur in groups. Pages 22-23.**

**III. 1. Among cultivated plums intermediateness of character is the best test of hybridity. While the pedigree record is not to be ignored, it is seldom reliable, and must always depend upon the test of intermediateness for its verification. The test of distribution can not be applied. Page 24.**

**2. A hybrid plum is to be classified by referring it to the several species whose characters it bears, rather than by reference to its pedigree. Pages 24-26.**

**3. Hybridity seems to be quite common among plums. All species may be intercrossed. The Japanese plums cross with the Chicasaws and the Hortulanas with especial ease. The Domesticas and Americanas cross with other groups with greater difficulty. Plums also cross with various cherries, peaches and apricots. Pages 26-28.**

**4. Each species has its peculiar value in plum breeding, and certain combinations are more promising than others. Pages 28-29.**

**5. The hybrid plums are likely to be eventually of great importance in fruit growing. Their introduction promises to mark an epoch in plum culture. Many of the varieties already produced are very promising, but none has yet been tested widely enough to warrant its general recommendation. Page 30.**

## II. HYBRID PLUMS.

A new factor has appeared in the study of plums. It is the production of hybrid varieties. This new factor is of immediate interest to the science of horticulture, and promises to be of very great consequence to the practical business of plum growing.

The number of hybrid varieties already brought to light is not large, and yet the array is quite respectable and altogether fit to arouse the liveliest imagination of the horticulturist. It seems especially proper and important that these first hybrids should be carefully put on record, since they mark the beginning of what will doubtless be a far-reaching change. It is also in the highest degree desirable that we should understand as well and as soon as possible the general limits, tendencies and effects of hybridity among plums.

These considerations have seemed to justify a more detailed study of varieties and variety characters than the practical value of most of the new plums here mentioned would merit alone. We have collected the best information obtainable regarding every hybrid variety of which we could learn, and though the majority of them perhaps, will never prove to be of practical value, they all help us to arrive at better generalizations. If, on the other hand, many varieties are given with very incomplete descriptions, their introduction here is justified on the same grounds. This is a record of beginnings, and beginnings are always fragmentary.

Without further preamble, then, we will proceed to study those varieties of more or less authentically hybrid origin which have come within reach.[†]

---

[*] The term hybrid is used here in its usual horticultural meaning, that is to designate a cross between two species. The writer very much regrets the attempt in certain quarters to give this word a different definition. The plea that one sometimes can not tell which are species and which are not, though true, (and notably so in plums), is no justification for abandoning the old-time definition of hybrid given above. The term hybrid is just as accurate as the term species, and we certainly are not yet ready to abandon species.

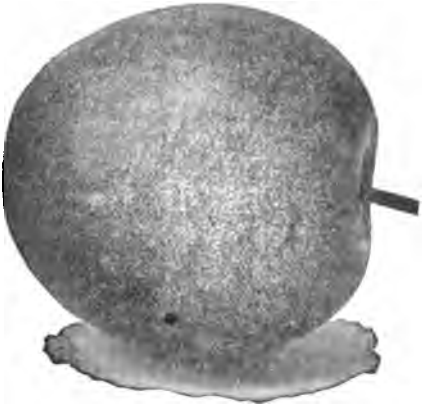
[†] As this is only the beginning of the history of hybrid plums, and as we would like to follow the subject further, the help of all horticulturists is solicited. Information of any sort relating to any variety or varieties of supposed hybrid plums would be gladly welcomed. *Original descriptions of new varieties in catalogues, periodicals or any other publications are especially desired.* Samples of leaves, twigs, or fruit will always be of service. Address EXPERIMENT STATION, BURLINGTON, VT.

## 1. DESCRIPTIVE AND HISTORICAL NOTES.

### A-248, *Burbank*, *New Creations*, 1893, *p*. 22.

Robinson X Botan; that is *Prunus angustifolia* X *P. triflora*.

Announced by Luther Burbank in 1893, but never sent out. Mr. Burbank informs me that he has destroyed it as he has now so many better varieties.



1. AMERICA.

### ALHAMBRA,
### *Burbank, unpublished.*

Probably Satsuma X Agen (Petite d'Agen, or French Prune;) that is *Prunus triflora* X *P. domestica*.

Fruit egg-shaped, large or very large, cavity medium shallow, abruptly rounded, suture shallow, apex pointed, color dark dull red, dots many small yellowish, bloom thin purplish, skin firm, flesh yellow inside, reddish outside, stone medium to large, flat, pointed, nearly smooth, cling, flavor brisk sub-acid, quality first-rate.

### ALLFRUIT, *Burbank, unpublished.*
### *Prunus simoni* X *P. triflora* (Burbank).

Fruit oblate, medium large, cavity deep, rounded, stem short, suture rather shallow, color pale red with many large and small yellowish dots and a thin white bloom, skin medium thick, flesh medium firm, bright yellow, stone medium to large, slightly flattened, semi-cling, flavor sweet and rich, fragrant, quality good to best. Leaf large, oval, pointed, rather finely double crenulate, and minutely glandular, rather thick, glistens as if varnished, petiole short, glandular.

### AMERICA, *Burbank*, *New Creations*, 1898, *p*. 3.

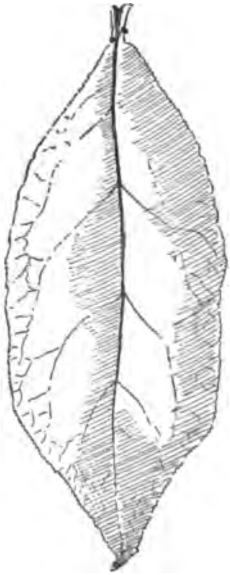
Botan X Robinson, Robinson seed; i. e., *P. triflora* X *P. angustifolia*.

Fruit nearly spherical, or a trifle elongated, medium to large, specimens measuring 42 mm in both longitudinal and transverse diameters, cavity medium depth, abrupt, stem short, suture faint, color bright 'golden yellow

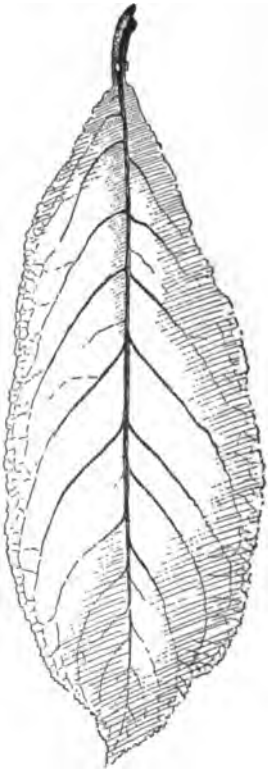
---

NOTE.—The illustrations of fruits are all exact size, but it must be remembered that pictures always look smaller than the objects. Illustrations of leaves are approximately half size. The leaf margins shown in figures 15 and 16 are somewhat magnified.

with pink blush, dots many white small indistinct, bloom thin white, skin thin somewhat astringent, flesh yellow medium firm, stone large oval slightly flattened cling, flavor not very striking, quality medium to good. This plum is beautiful, but not of high quality. (See Fig. 1.)



2. APPLE.



CHALCO.

APPLE, *Burbank, New Creations*, 1898, *p.* 2.

A hybrid seedling of the second generation. "No doubt Satsuma and probably Robinson are in its line of ancestry." This would mean *P. triflora* X *P. angustifolia*.

Fruit spherical to oblate, large, cavity medium deep gently rounded, stem short, suture faint, color deep reddish purple. Foliage large and thrifty, leaves 4½ inches long, rather narrow oval, tapering below and somewhat abruptly pointed above, margin finely glandular crenulate. (See Figs. 2 & 3.)

### BARTLETT, *Burbank in Van Deman, Rural New Yorker* 57, *p.* 653, *September* 24, 1898.

Delaware crossed with Simon; that is *Prunus triflora* X *P. simoni.*

Fruit ovoid, size medium, cavity deep rounded, stem medium length, rather slender, suture evident, apex pointed, color dark red, dots many yellowish, bloom white, skin thin, flesh soft and yellow, stone large. The flavor is said to be very fine, closely resembling that of a Bartlett pear, whence the name. Mr. Burbank says "the tree grows perfectly upright, like a Lombardy poplar, with very glossy leaves, very productive."

### BESTOVALL, *T. V. Munson, unpublished.*

Described as a hybrid of Miner pollinated with Abundance, which would be *P. hortulana** X *P. triflora.* I have seen only the foliage which is much like Miner, showing no Triflora characters.

Leaves large, coarse, rough, with a tendency toward a faint pubescence on the veins underneath, broadly oval, blunt pointed, base strongly rounded, margins coarsely double serrate, glandless, petioles strong, with one or two small glands. Mr. Munson describes the fruit as "very late, fair size, firm meaty fine, sure and prolific."

3. APPLE.

### BLACKMAN, *Van Deman, Rpt. U. S. D. A.* 1886, *p.* 261.

Thought to be a peach-plum hybrid. The evidence of hybridity lies in the sterility of this variety and in its somewhat intermediate characters. This is further strengthened by comparison with Mule of J. W. Kerr, which see, page 17.

The variety is of no interest except as a curiosity. A full account of it may be found in U. S. D. A. Rpt. 1886, p. 261; also in same reports, 1887, p. 636; also in Cornell Exp. Sta. Bul. 38, (1892) p. 40.

### BRECK, *F. T. Ramsey, unpublished.*

Thought to be a hybrid of Japanese stock with American, perhaps of Kelsey pollinated with Wildgoose. From an examination of the leaves only I hesitate to form an opinion as to its parentage.

---

*For convenience of discussion the name *Prunus hortulana* is retained here, though it is understood not to represent an independent species. See page 22.

The leaves are medium large, rather broadly oval, blunt pointed, abruptly tapering below, margins finely crenulate with many conspicuous small glands, (see page 20), petiole short, usually glandless.

Mr. Ramsey writes that Breck originated in the orchard of Joseph Breck, of Texas. This variety will probably be introduced during 1899.

### BURSOTO, *Theo. Williams, unpublished.*

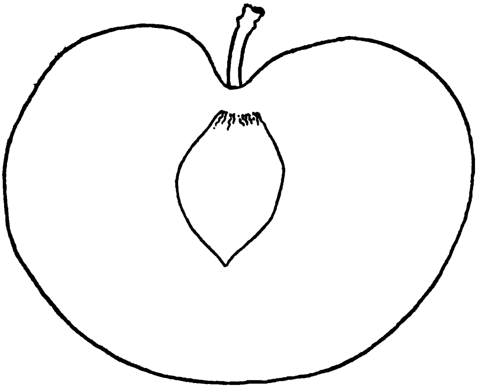
Said to be a hybrid of Burbank with DeSoto, which would be *Prunus triflora* X *P. americana.* The tree and foliage are so strongly Americana in character that the variety may best be classed there unless the fruit, which I have not seen, shows distinct Japanese characters.

Leaves very Americana-like in character, though rather thin and soft, large, round oval, pointed above and rounded below, glabrous above, rather roughly tomentous over the entire lower surface, margin coarsely deeply irregularly doubly-jagged toothed, petiole strong, with one or two glands.

### CEL, *Burbank, unpublished.*

Said by Mr. Burbank to be Myrobalan X Wickson; "a tri-specific hybrid." The fruit strongly suggests *Prunus americana* parentage, which would make the pedigree of this variety as follows: *P. cerasifera* X *P. triflora* X *P. americana.* Or if we take the view of Wickson suggested on page 21. the parentage of Cel would be *P. cerasifera* X *P. triflora* X *P. simoni.*

Fruit egg-shaped, medium size, rounded cavity, stem medium long and strong, suture indistinct, apex pointed, color bright transparent yellow, stone medium large, cling, flavor very Americana-like without astringency, quality good. Leaf quite Cerasifera-like, somewhat cordate, rather sharply though finely double serrate.



4. CHALCO.

### CHALCO. *Burbank, New Creations,* 1898, *p.* 4.

Simon X Burbank; *i. e. Prunus simoni* X *P. triflora.*

Fruit strongly oblate, much the shape and color of a tomato, large, 45 mm deep and 58 mm broad, cavity medium deep, gently rounded, stem short, suture medium deep, surface smooth, color dark red solid, dots many small indistinct, skin medium thick, flesh yellow firm and meaty, stone small oval only slightly flattened, nearly free, flavor sweet and sugary, quality extra, none of the peculiar Simon plum flavor.

### CHICRIGLAND, *T. V. Munson, unpublished.*

Described as a secondary hybrid, combining three species, viz.: *Prunus chicasa* X *P. rivularis* X *P. glandulosa.**

Fruit described by Mr. Munson as the size of Golden Beauty, fuzzy, rich orange red, stone rounded appearing wooly after removal of the flesh, flavor entirely distinct and agreeable. The tree is said to be a strong grower, with zigzag weeping branches. Leaves rather small, elliptical pointed, rounded or abruptly tapering below, rather thick, rough and harsh, margin finely glandular crenulate, petioles short and minutely glandular.

Originated with T. V. Munson, Texas, from seed of a plum grown by F. M. Ramsay, Lampasas County, Texas.

### CLIMAX, *Burbank, unpublished.*

Royal, *Van Deman, Rural New Yorker*, 57, (1898) *p.* 653. *Not Downing and others.*

Botan pollinated with Simon. *Prunus triflora* X *P. simoni.*

5. CLIMAX.

Fruit strongly heart-shaped, very large, as large as an ordinary peach, cavity deep and abrupt, stem short and strong, suture plainly marked but not deep, apex rounded, color deep dark red, many yellow dots large and small, skin thick firm, flesh yellow firm, stone large somewhat turgid. roughened, free, flavor sweet rich fruity, quality fine. Season earliest. This is justly regarded by Mr. Burbank as being one of his most valuable productions. If, upon extended test, it proves hardy, fruitful, and otherwise reliable, it will be an advance, in many respects, upon any plum now known.

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*This so-called *Prunus rivularis* undoubtedly represents the Wayland group of native plums, formerly classed with *P. hortulana.* For a full discussion of the botanical technicalities involved see F. A. Waugh, Notes on Sundry American Plums, Bot. Gaz. 26, (1898) p. 48. *P. chicasa* is a synonym of *P. angustifolia.*

COLEUS, *J. S. Breece, unpublished.*

Thought to be Kelsey X Pissard. *Prunus triflora* X *P. cerasifera.* If one may judge from the leaves alone this is a very well blended hybrid.

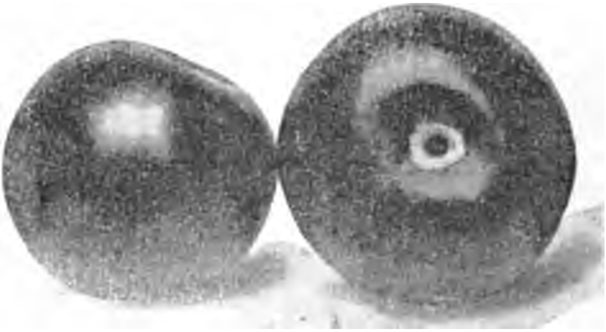
Leaves medium to large, ovate, tapering at both ends about equally, deep rich red, glabrous above, a little fine pubescence along the midrib underneath, margin medium coarsely double serrate, petiole strong, with small glands.

COMPASS CHERRY, *H. Knudson, Minn. Horticulturist, April,* 1896, *p.* 132.

From Sand cherry pollinated by Miner plum. *Prunus besseyi* X *P. hortulana.* Undoubtedly a true hybrid.

This cherry-plum, which I have seen only as hebarium specimens, is said to have a vigorous, upright-growing tree, the foliage is large, ovate, rather coarse, sometimes somewhat like the sand cherry but much coarser, fruit spherical or a little ellipsoid, about an inch in diameter, dark-red, of good quality. Is thought by some to be a valuable fruit, but has not been much planted.

Originated by H. Knudson, Springfield, Minn., in 1894, and introduced by C. W. Sampson, Eureka, Minn., in the fall of 1897.



6. EXCELSIOR.

DANIEL WEEPING, *J. L. Normand.*

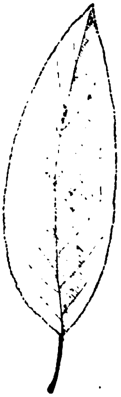
This tree which I have seen growing in the Cornell University orchards has the aspect of a hybrid, though no record of its origin is accessible.

The tree is bushy spreading and drooping; leaves thick and tough, ovate, acute pointed, rounded at the base, finely and smoothly crenulate, petioles short and strong with 2-4 glands, stipules often present with younger leaves.

Originated with Dr. Daniel, Louisiana.

### EXCELSIOR, *G. L. Taber*, *Cat.* 1897.

From seed of Kelsey pollinated by Wildgoose or DeCaradeuc, probably the former. This would be *P. triflora* X *P. hortulana*. This variety is conspicuously a hybrid. Its characters suggest Wildgoose, though a comparison of the blossoming seasons of Kelsey, Wildgoose and DeCaradeuc in Florida would make it seem very likely that the pollen-bearing parent was DeCaradeuc.



7. EXCELSIOR.

Fruit medium or large, flattened or a trifle pointed like Abundance, no suture, color deep solid wine-red with very minute almost invisible white dots and heavy light-bluish bloom, stem short, skin firm and without astringency, flesh firm yellowish, with reddish color toward the pit, stone flattened medium size cling, quality fine. Season June 15 in Florida, July 20 in Maryland.

Tree vase form with long slender branches; leaves rather large moderately narrow oval, tapering above, tapering or somewhat rounded at the base, glabrous, margin finely irregular crenulate with prominent but minute glands, petiole rather short with 1-3 small glands; flowers small, scattered, white.

Originated by Geo. L. Taber, Glen St. Mary, Fla., in 1887. A very promising plum.

### FOREWATTAMIE, *Theo. Williams, unpublished.*

A hybrid between Forest Garden and Pottawattamie, which is *Prunus americana* X *P. angustifolia*. The foliage and young growth give strong evidence of an unusually equal blending of the two species. I have not seen the fruit.

Leaves oval tapering at the point and rounded at the base, thin, irregularly double serrate with blunt teeth and inconspicuous glands, slightly tomentous on the veins along the back, petiole rather long and slender, usually with 2-3 small glands. In general the foliage has a softened Miner-like look.

Originated with Theo. Williams, Benson, Neb.

### GARNET, *J. S. Breece in S. B. Heiges*, *Rpt. Pomologist, U. S. D. A.*, 1895, p. 45.

Kelsey X Pissard? Kelsey seed. This would be *P. triflora* X *P. cerasifera*.

The account of its origin given by Heiges (loc. cit.) is as follows: "Came up in spring of 1891 under a Kelsey tree. . . . Its characteristics indicate that it is a chance cross between Pissard that grew near, and the Kelsey under which it grew." This evidence does not seem to have much value of itself.* I have specimens of the foliage, but not having seen the tree and fruit I must, for the present, consider this variety subject to removal from the list of hybrids.

Heiges gives the following description of the fruit: "Roundish oval large smooth dark garnet red, dots minute russet, bluish bloom, cavity small regular, of medium depth, flaring, marked with blue bloom, stem short, of medium caliper, suture very shallow and almost obscure, skin thin moderately tenacious bitter, stone medium size oval cling, flesh yellowish translucent, stained with red on one side, mild almost sweet. good. Season June 25 to 30," [in North Carolina]. Leaves sent me by W. A. Taylor from the United States Department of Agriculture are round oval quite broad, abruptly tapering above, tapering or rounded below, roughly double serrate slightly glandular margins, glabrous above, slightly tomentous on the midnerve underneath, petiole short and stout, with inconspicuous glands or glandless, large feathery deciduous stipules.

8. GOLDEN.

GOLDEN, *Burbank, New Creations* 1893, *p.* 17.
Gold of *Stark Bros. Cat.* 1896.

Robinson X Botan, Robinson seed, *i. e.*, *Prunus angustifolia* X *P. triflora*.

Fruit round or oblate, medium to large, cavity medium deep rounded, stem short, no suture, color bright golden yellow overlaid when fully ripe with a fine pink blush, very pretty, dots many yellow very dim. bloom thin white, skin thin but strong, flesh rather soft and watery, yellow, stone medium or small oval but little flattened, strongly keeled, cling, flavor sprightly, quality good. Season July 15 to Aug. 1. Tree dwarfish, rather Chicksaw-like in general appearance, leaves small or very small, narrow oval, tapering above, tapering or unequally rounded at base, the upper surface glabrous, slightly tomentous underneath especially along the veins, margins irregularly dull crenulate glandular, petiole short rather stout with 2-3 small glands.

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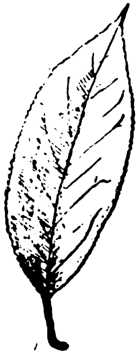
*Several cases have come to light in which hybridity has been suspected on the evidence of reddish colored foliage. But red leaved seedlings occur rather frequently without any possible antecedent cross. They are especially common from Kelsey, though not rare from other Japanese varieties. Pissard itself is probably only another such sport, and J. W. Kerr has produced a red-leaved seedling from DeCaradeuc.



9. GOLDEN.

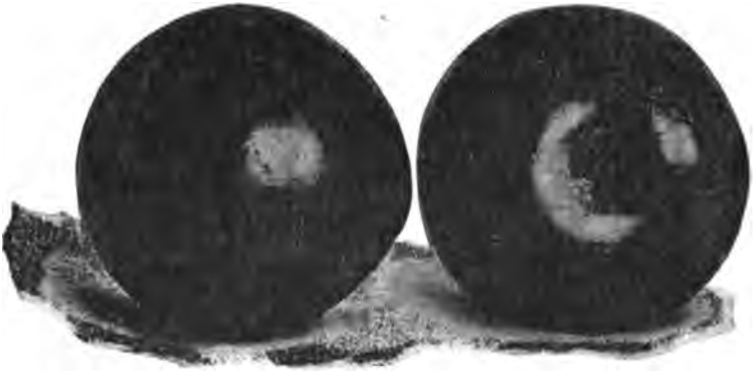
The Chicksaw parentage preponderates in this variety, as in many others of its class. The characters which are not plainly Chicksaw are mostly anomalous, there being very little apparent evidence of Japan parentage. An interesting variety and worth a trial.

This variety has sometimes been confused with Juicy, but the two are altogether distinct, as may be seen from a comparison of the figures and descriptions here given.

Mr. Burbank has sent me several very promising seedlings of Golden.

GONZALES, *F. T. Ramsey, Cat.* 1897.

**Of unknown parentage, but undoubtedly a hybrid. It is probably a combination of *Prunus triflora* with *P. hortulana* or *P. angustifolia*.**

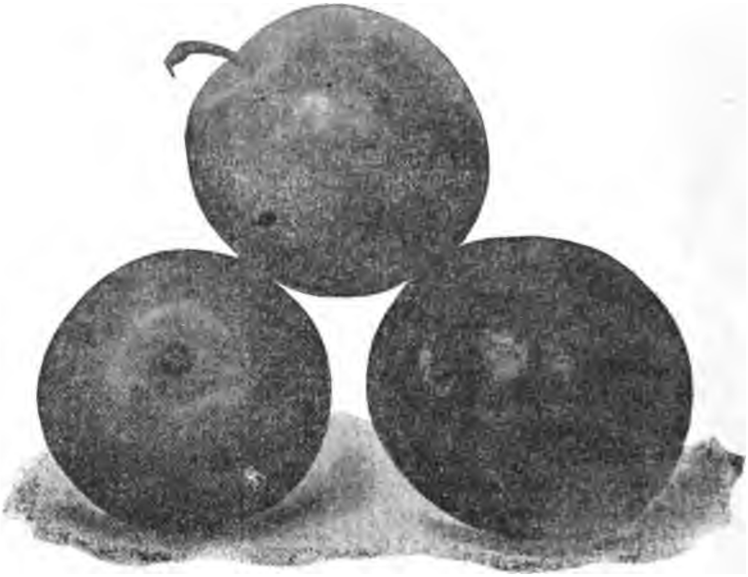


10. GONZALES.

**Fruit large, about the size and shape of Burbank, nearly spherical, sometimes a little irregular, and occasionally slightly pointed, bright wine red indistinctly striped and splashed with deeper crimson, with many small yellowish dots, bloom white, skin moderately thick and firm, not harsh nor astringent, flesh rather firm and meaty, light red sweet and pleasant, stone medium size oval flattened cling, quality first rate. See fig. 10. Leaves narrow**

oval tapering almost equally at both ends, margin finely crenulate and minutely glandular, surface glabrous above, a few small fine hairs on the mid-nerve at the back, petiole rather short and slender with usually two small glands.

Originated in Gonzales, Texas, about 1894. A very promising plum.



11. JUICY.

### GOVALLE, *F. T. Ramsey*, *Cat.* 1898.

Thought to be a Japanese-Chickasaw hybrid. Appearances indicate the correctness of this view.

Fruit large, dark wine red, with indistinct stripes of yellow showing through, many small yellow dots, skin thin, stone medium large oval slightly flattened, cling.

Originated with Mr. Jos. Breck, Texas, and named after the old Mexican grantee of the land on which the original tree grows. Introduced by F. T. Ramsey in 1898.

### HOLLAND, *W. A. Yates*, *Circular*, 1897.

From Kelsey seed, supposed to be crossed with Lonestar. This would be *Prunus triflora* X *P. angustifolia*. Probably a true hybrid.

Fruit size and form of Abundance, greenish yellow splashed with red, flesh moderately firm and juicy, vinous, adheres slightly to stone. Season late June, in Texas.

Tree vigorous of rather compact stocky habit, leaves medium large, ovate or lanceolate, tapering at both ends, thin flat and glabrous, margins finely glandular serrate, petioles medium with occasional small glands.

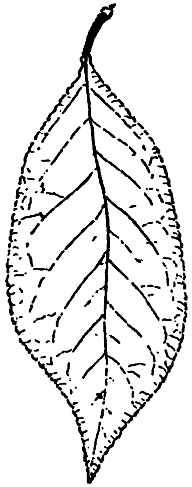
Originated by D. H. Watson, Brenham, Tex.

JUICY, *Burbank, New Creations* 1893, *p.* 20.

A seedling of Robinson pollinated with Botan. *Prunus angustifolia* X *P. triflora*.

Fruit irregularly ellipsoid, medium size, cavity medium deep rounded, stem medium long strong, color clear yellow, many indistinct white dots and a thin white bloom, skin thin, bloom thin white, flesh yellow, rather soft and watery, stone medium large flattened pointed cling, quality fair to good. Season last of July. Tree a strong rampant upright grower; leaves medium to large, ovate, taper pointed, rounded at the base, glabrous, margins finely serrate, petiole rather short with small glands.

Introduced by John Lewis Childs in 1894. Not to be confused with Golden, which see.



12. JUICY.

KELSEY 1, KELSEY 2, KELSEY 3, *Theo. Williams, in Cat. J. W. Kerr* 1898, *p.* 18.

All said to be hybrids from Kelsey seed crossed with Early Cherry,— *Prunus triflora* X *P. cerasifera*.

I have seen only foliage and nursery trees of these varieties. The foliage strongly suggests a hybrid origin. They have not yet been tested. Originated with Mr. Theo. Williams, Benson, Neb.

K. P. 193. Purple-leaved hybrid plum. *Burbank, New Creations* 1893, *p.* 16.

This is another purple leaved seedling of Kelsey, the coloring of the leaves being the chief evidence of accidental pollination by Pissard. As mentioned elsewhere this does not seem to make a very strong case. This variety was never sent out, and Mr. Burbank now says that he has many other varieties which excel it.

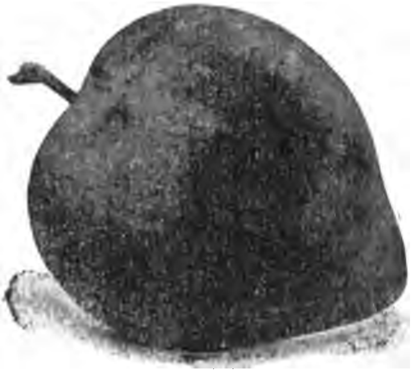
LANNIX, *J. S. Breece, in S. B Heiges. Rpt. Pom. U. S. D. A.* 1895, *p.* 45.

Thought to be a cross of Abundance and Wildgoose. The following description from Heiges (loc. cit.) plainly suggests Wildgoose, but does not indicate the participation of Abundance.

"Fruit oval, medium size, color coppery red, a little darker than Wildgoose, dots minute light russet, bloom light blue, cavity medium size round deep abrupt, stem short, suture very shallow, skin thin tenacious bitter, stone large oval cling, flesh yellowish translucent slightly fibrous, flavor mild subacid rich, quality good. Season [in N. C.] June 20-25." Leaf rather large, oval, pointed, rounded at the base, rather leathery in appearance, smooth on both sides, margin finely crenulate-serrate, glandless, petiole short and stout, usually glandless.

### LATE CONICAL. *Burbank, unpublished.*

*Prunus triflora* X *P. simoni.*



13. LATE CONICAL.

Fruit strongly conical, rather large, cavity shallow abrupt, stem short, suture shallow, color red and purplish over yellow, dots many large yellow, bloom heavy purplish, skin medium thick, flesh yellow solid firm, stone medium size flattened pointed free, flavor sweet and agreeable, quality superfine. The finest quality of any plum yet examined, though Mr. Burbank thinks this is not a fair comparison. Tree a rapid grower, form of Burbank. Leaves medium to large, broadly oval, abruptly pointed, tapering at the base, rather stiff. margins rather coarsely double crenulate, petiole large, set with glands.

### LOUISIANA, *Bailey, Cornell Exp. Sta. Bul.* 139, (1897) *p.* 377.

Probably *Prunus triflora* X *P. hortulana* or *P. angustifolia.*

Fruit irregularly ovoid, medium to large, cavity shallow rounded, stem medium, visible suture, color greenish overlaid with dull red, dots many large whitish, bloom thick white, skin medium thick, flesh yellow stringy, stone large oval flattened cling, flavor sprightly subacid good, quality fair. Season Sept. 1. Tree a slender and spreading grower, strongly suggesting Wildgoose, leaves medium size, tapering at both ends, very finely glandular crenulate, glabrous, petioles glandular. This variety has the bad habit of ripening unevenly and dropping from the tree before maturing. It has proved hardy thus far at Ithaca, N. Y.

### MANKATO, *S. D. Richardson & Son*, 1890.

This variety is said to have been grown from seed of German Prune, and was thought to be a hybrid because its characters are purely Americana. Its hybridity may be regarded as very doubtful. Meanwhile it is properly classed in the Americana group, and not among the hybrids.

### MARIANNA.

Supposed by Bailey (Cornell Exp. Sta. Bul. 38, p. 32), to be possibly a hybrid between the Myrobalan and some American plum, possibly Wildgoose. This supposition is more fully discussed on page 23 of this bulletin. The variety is so well known that it need not be described here.

### MARYLAND, *J. W. Kerr*, *Catalogue* 1896.

A seedling of Utah Hybrid, which see. *Prunus watsoni* X *P. besseyi*.

Fruit round or slightly ellipsoid, small, dark red or maroon, stone medium size pointed cling. Season July 15-25, [in Md.] Leaves large oval pointed, rounded at the base, thickish, harsh, smooth above, tomentous below, margin irregularly crenulate and minutely glandular, petiole short strong, with 2-3 prominent glands.

Of no value in the orchard.

### MINNIE, *J. S. Breece*, *unpublished*.

Probably Abundance pollinated with Wildgoose. *Prunus triflora* X *P. hortulana*.

Leaf very much like Abundance, large, slightly obovate, abruptly pointed, rounded at the base, smooth on both sides, margin irregularly double-crenulate-serrate, with occasional small glands, petiole short and stiff, with several glands.

### MONOLITH, *J. S. Breece*, *in S. B. Heiges*, *Rpt. Pom. U. S. D. A.* 1895, *p.* 46.

"It appears to be intermediate between Botan [Abundance] and Wildgoose." This variety has exactly the same standing as Lannix, and like that variety appears from the description to show strong Wildgoose characteristics without a corresponding balance of Japanese marks.

Heiges describes the fruit as follows: "Roundish, slightly conical, medium size, bright coppery red with longitudinal stripes of darker red, dots numerous minute russet, bloom profuse pale blue, cavity medium in size and depth, round flaring, stem slender, suture very shallow, skin thin tenacious bitter, stone medium size oval semi-cling, flesh yellowish translucent, meaty tender juicy, somewhat fibrous, flavor mild subacid rich, quality good to very good. Season July 15 [in N. C.]

### MULE, *J. W. Kerr*, *Catalogue*, 1896.

Troth Early peach crossed on Wildgoose plum. An authentic hybrid.

Tree with very much the form of Wildgoose plum, but looking more like a peach on account of the peach-like foliage. Twigs and leaves quite peach-like, the latter, however, rather broader and stiffer than peach leaves, sharply tapering at the point, rounded at the base, margin sharply and irregularly appressed glandular crenulate, petiole short and stiff, with three to six glands. The tree forms flower buds which never blossom. They contain deformed anthers but no pistils. The variety is therefore perfectly sterile.

### NIKKO, *Burbank, Special Circular, Sept.* 1, 1898.

Syn. Apple, by mistake in a few cases.

Parentage unknown, but probably Satsuma on one side. I have not had the opportunity to examine this variety, which is characterized as a good dark red, red-fleshed, conical plum.

### PENDENT. *Theo. Williams in J. W. Kerr, Cat.* 1898, *p* 19.

Said to be from seed of Pottawattamie pollinated by Forest Garden. This would be *P. angustifolia* X *P. americana.* I have seen only the leaves, and these seem to be intermediate between the supposed parents.

Leaves medium large, long ovate, taper pointed, rounded at the base, rather stiff and harsh, especially harsh on the under side, margin medium finely double serrate with an occasional minute gland, petiole slender, usually with two small glands.

Originated with Theo. Williams, Benson, Nebr.

### PENNOCK, *Chas. E. Pennock, unpublished.*

From seed of Rocky Mountain Cherry thought to be pollinated with (Moore's) Arctic. This would be *Prunus besseyi* X *P. domestica.*

The meager specimens which I have examined show a preponderance of *P. besseyi* characters, but also suggest *P. domestica* in some respects.

Mr. Pennock describes the fruit as follows: "Nearly round, about an inch in diameter, deep blue in color with a bloom, having a slight suture, flavor between a plum and cherry, excellent to eat out of hand or for preserves or canning; tree of dwarfish growth, but upright. Was raised from seed planted in 1893." The leaves are medium size, ovate, tapering at both ends, rather coarsely serrate, flat and thickish, with some fine tomentum on either side, petiole short and stiff, occasionally a small gland at the base of blade. The stone is small, round, and cherry-like.

Mr. Pennock, Fort Collins, Colo., the originator, says he now has Early Richmond cherry and Arctic plum growing nicely on the same stock of this variety. He has thus far found it a very useful stock for plums.

### PRESERVER, *W. A. Yates, Circular,* 1897.

Probably a cross of Kelsey with Early Red, Kelsey seed. This would be *Prunus triflora* X *P. angustifolia.*

Fruit dark red, flesh red firm. Season June [in Texas] Tree vigorous, compact, leaves small, lance-ovate tapering at both ends, thin flat and glabrous, margins finely glandular serrate, petioles rather short and slender with occasional small glands.

Originated with D. H. Watson, Brenham, Tex.

### RAGLAND, *W. A. Yates, Circular*, 1897.

Probably a hybrid; from Kelsey seed supposedly pollinated by Yellow Transparent; i. e., *Prunus triflora* X *P. angustifolia.*

Fruit large roundish clear golden yellow, flesh juicy melting. Season June, in Texas. A vigorous, compact upright grower, leaves medium size, slightly obovate pointed, tapering at the base, thin smooth glossy, margin finely glandular serrate.

Originated with D. H. Watson, Brenham, Tex.

### RUBY, *J. S. Breece, unpublished.*

Supposed to be Botan [Abundance] pollinated by Wildgoose. *Prunus triflora* X *P. hortulana.*

Leaf medium size, oval, pointed, tapering or slightly rounded at the base, rather stiff and harsh, margin finely and irregularly crenulate, petiole medium length, stiff and strong, with small glands. I have not seen the fruit.

### SCRIBNER, *J. S. Breece, in S. B. Heiges, Rpt. Pom. U. S. D. A.* 1895, *p.* 46.

"Considered a probable cross of the Wildgoose on Botan" [Abundance.] This plum falls into exactly the same category as Lannix, which see.

This fruit is described by Heiges (loc. cit.) as follows: "Roundish oval large, bright crimson, dots numerous minute russet, bloom pale bluish, cavity medium size deep flaring, stem short slender, suture shallow, skin medium thick slightly bitter, stone medium size oval cling, flesh yellowish translucent tender melting juicy somewhat fibrous, mild subacid, quality good. Season, early July [in N. C.]"

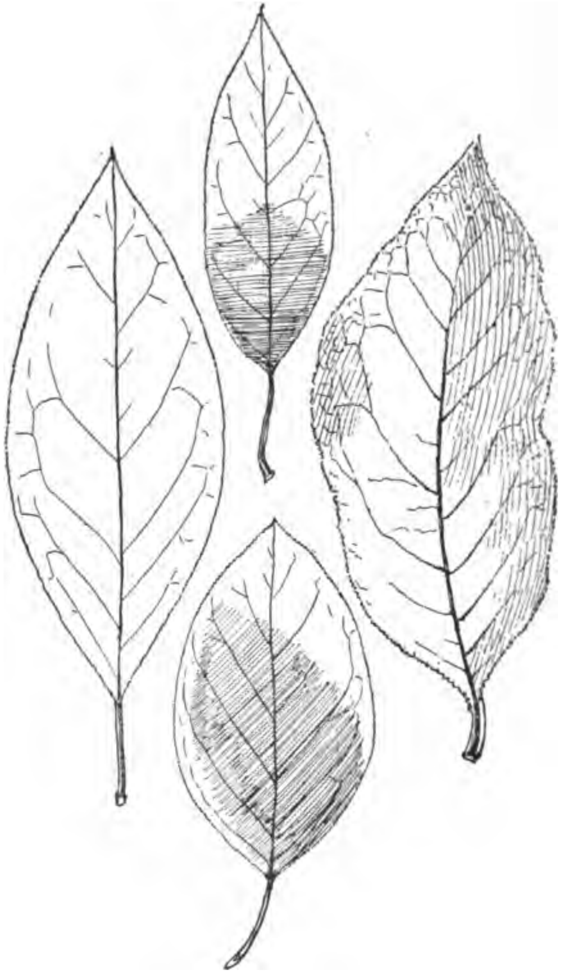
### SIROCCO, *J. S. Breece, in S. B. Heiges, Rpt. Pom. U. S. D. A.* 1895, *p.* 47.

Said to be "a probable cross of Botan [Abundance] and Marianna."

The fruit is described by Heiges (loc. cit.) as follows: "Roundish oval, medium size, coppery red under streaks of yellow, dots minute light russet, bloom light blue, cavity small, very shallow, abrupt, stem short slender, suture a trace, skin thin, stone medium size, oval, flesh reddish yellow near the skin and yellow near the stone, fine grained, very juicy, sweet subacid, quality good. Season middle July [in N. C.]"

### SOPHIE, *J. W. Kerr, Cat.* 1894.

This variety was introduced as "a seedling of Wildgoose, supposed to be crossed with German Prune." It appears, however, to belong properly in the Wildgoose group, where Mr. Kerr now classifies it.



YATES.

BRECK. HOLLAND.

PRESERVER.

### UTAH HYBRID, (Cherry), *J. E. Johnson.*

*Prunus utahensis, Dieck in Dippel, Laubholzkunde* 3, *p.* 634 (1893).

Bailey decided in 1894 that "all botanical evidence goes to show that this plant is a hybrid of *Prunus besseyi* [the Rocky Mountain dwarf cherry] and the Sand plum, *P. watsoni,*" and he gave the following botanical details bearing out this supposition.*

The Black Utah Hybrid cherry originated with J. E. Johnson at Wood River, Nebraska, on or near the Platte river, probably sometime in the sixties. Mr. Johnson grew native dwarf cherries and sand plums in his garden. Seeds of these cherries were sown. One of the seedlings was saved and propagated. Mr. Johnson soon afterward moved to Utah, whence, it appears, he distributed this variety as the Utah Hybrid cherry.

Plant dwarfish, 3-4 ft. high, twigs somewhat zigzag like *P. watsoni* leaves small, narrow orate, pointed at both ends, somewhat conduplicate and a trifle rough, margins crenulate, glandless, petioles medium short, occasionally with small glands, fruit small, spherical, cherry-like, but with a plum-like bloom, stone round cherry-like.

This hybrid has not proved to be of any practical value, except perhaps in rare circumstances. One of the best of the class is Mr. Kerr's seedling, Maryland, which see.

### WATSON, *W. A. Yates, Circular,* 1897.

Probably a hybrid; from Kelsey seed, thought to be pollinated by Lonestar. This would be *Prunus triflora* X *P. angustifolia*.

Fruit large, rather pointed, red when fully ripe, flesh yellow, juicy, melting, adhering slightly to the pit, which is small. Tree vigorous, of some what open habit, leaves medium to large, ovate-lanceolate, taper pointed, tapering or slightly rounded at the base, thin and glabrous, margins finely serrate with minute glands, petiole short, sometimes with small glands. Said by the introducer to be very prolific and valuable.

Originated with D. H. Watson, Brenham, Tex.

### WICKSON, *Burbank.*

This variety has always been classified as a Japanese plum, and the originator, Luther Burbank, says that it has grown from Burbank seed pollinated by Kelsey. But Bailey† has expressed a suspicion that *Prunus simoni* entered into the parentage of this variety,—a suspicion which is so strong in my own mind that I do not hesitate to classify it as a hybrid. (See remarks on the classification of hybrids, page 24). Tree, foliage and fruit all partake of the characteristic marks of the Simon plum; and whatever its real parentage may be, the variety can be well described as intermediate between Kelsey and Simon.

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*Cornell Exp. Sta. Bul. 70, (1894) p. 263.

†Cornell Exp. Sta. Bul. 139, (1897), p. 381.

YATES, *W. A. Yates, Circluar*, 1897.

Probably a hybrid; from Kelsey seed thought to be pollinated by Lonestar. This is *Prunus triflora* X *P. angustifolia*.

Very much like Holland, from which we need not distinguish it here. Originated with D. H. Watson, Brenham, Tex.

### 2. ON CERTAIN GROUPS OF HYBRIDS.

Besides the varieties already named and described and which are mostly the intentional or unintentional products of cultivation, there are certain large groups of hybrids occurring in nature. This subject has been so fully discussed elsewhere that it is unnecessary to go into it in detail here.* It will be sufficient now to say that, in the view of certain plum students at least, the Hortulana plums, consisting of three large groups,—the Wildgoose, the Wayland and the Miner,—are to be regarded as a great family of hybrids. On purely speculative grounds we may assume that the Wildgoose group is the result of various primary crosses between the wild *Prunus americana* and *P. angustifolia*, and that the Miner group represents secondary crosses between the Wildgoose group and the Americanas. With somewhat less certainty we may assume that the Wayland group has arisen from crosses of *P. augustifolia* with the southern form of the Americana plum, *P americana mollis*.

These assumptions are in a fair way to be proved or corrected by experimental evidence. As soon as a sufficient series of Americana-Angustifolia hybrids are produced in cultivation they may be compared with the existing varieties of the three groups in question in the expectation of interesting revelations. It must be admitted that the few Americana-Angustifolia hybrids now known do not confirm the hypothesis set forth above. In figure 15 will be seen tracings from the leaf margins of Forewattamie and Pendent, both hybrids of this class, compared with their specific parents. One is struck at once by the intermediateness of character exhibited by the hybrids. But if one compares the margins of Forewattamie and Pendent with that of Wildgoose, shown in fig. 16 resemblance fails. Wildgoose, judged by leaf margin alone, is much nearer the Chicasaws than the Americanas, while the primary hybrids, Pendent and Forewattamie, are approached most closely by certain varieties of the Wayland group. It might be said however that some varieties of the Wildgoose group have leaf margins less Chicasaw-like than Wildgoose. This is a complicated subject, and well worth separate treatment, but we cannot go into it further here.

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*These discussions may be found in Vt. Exp. Sta. Rpt. 10, (1897), p. 105; Garden and Forest 10, (1897), 340; Botanical Gazette, 26, (1898), p. 50. See also Bailey, Evolution of our Native Fruits, (1898) p. 195.

The Marianna with certain similar plums comes up for consideration in this connection. Bailey* has given special study to Marianna and DeCaradeuc, and has concluded that the former is possibly a hybrid between the Myrobalan plum, *Prunus cerasifera*, and some native sort, perhaps Wildgoose, and that DeCaradeuc is pure Myrobalan. This conclusion has recently been reiterated.† There are several varieties of this group which Bailey has not studied. Among these I have notes on Brill, Frostproof, Hattie, Hogg, and Tarleton. These are all plainly related to Marianna, but they are all, with the possible exception of Hattie, to be readily referred to *Prunus cerasifera*. While I have not given this group the detailed study which I hope to devote to it at some future time, my present belief is that none of the varieties mentioned is to be regarded as a hybrid, except, perhaps, Marianna. This seems to me to be probably a Myrobalan-Chicasaw hybrid.

It is very instructive to note how the horticultural hybrids now run in groups. Mr. Williams of Nebraska has a group of Triflora-Cerasifera hybrids; Mr. Ramsey in Texas has a little family of Triflora-Hortulana hybrids; Mr. Breece in North Carolina has a similar series; while the late D. H. Watson of Texas, produced a very homogeneous group of Triflora-Angustifolia crosses. Even among the multifarious productions of Mr. Burbank one can not fail to be struck by the pre-eminent conspicuousness of the Simoni-Triflora hybrids.‡ Hybrid plums seem to go in flocks, like wild ducks.

This fact is very suggestive. In the first place it encourages the plum breeder, for he may always expect a good quantity of material from which to select. In the second place, remembering that most of these hybrids have come from accidental cross-pollination, we are taught that crossing in the orchard is very common. Where varieties of the same blossoming season are planted together their mixture is almost certain. It remains only to save the pits and grow the seedlings. The chance of securing hybrid varieties is always good.

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*Cornell Exp. Sta. Bul. 38, (1892), p. 32.

†Evolution of our Native Fruits, (1898), p. 203.

‡A number of supposed hybrids grown by C. G. Bushnell, Centerbrook, Conn., and thought to be of Triflora-Domestica and Triflora-native origin are noted in *Rural New Yorker*, 62, p. 626, Sept. 10, 1898. No further information concerning them is at hand.

## III. HYBRIDITY AMONG PLUMS.

### 1. TRUSTWORTHY EVIDENCES OF HYBRIDITY.

There is a strong prejudice in almost all quarters against admitting the hybrid origin of any plant except upon the most indubitable evidence. This is a good, conservative, scientific principle, but it may be carried too far. It is rather a near sighted way of looking at the matter, though not uncommon, to think that careful hand-pollination of emasaculated blossoms, followed by painstaking rearing of the seedlings, furnishes the only basis upon which hybridity can be really certified. We are taught by all our theories, and know from observation of the facts, that hand pollinations made with the greatest care give very uncertain results. The offspring when secured may resemble one parent alone, in which case the strong presumption is that the hybridization was a failure. That is the extrinsic characters of the plant are relied upon for the final proof of its parentage.

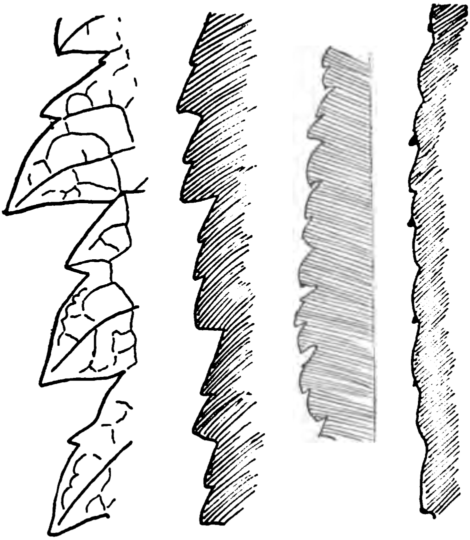
This overturns at a stroke all our prejudices, but it puts the subject in its proper light. On the whole the practical horticulturist cares very little, whether a plant is a hybrid or not unless its visible characters show some evidence of its pluri-specific parentage. With plants occurring wild the distribution of a strange form is an important evidence of hybridity, as in the case of *Prunus hortulana;* and for a study of hybridity in general, authentic pedigrees are indispensable; but for all practical, and for most scientific purposes, intermediateness of character is the only practicable and the most reliable test of hybridity.

The greatest caution, however, must be exercised in following out this rule. It will not do to jump at conclusions in such an intricate matter. No one can determine at the first glance whether the characters of a new variety are drawn from several definable sources. It is often difficult to decide what the relationships of a given variety are, even after long study of all the characters of plant, foliage, blossom, and fruit. It is a very serious problem to classify some varieties which belong to only *one* species! Before the pomologist refers a new plum to *two* species he must give the evidence his most searching scrutiny.

### 2. CLASSIFICATION AS AFFECTED BY HYBRIDITY.

What has just been said leads directly to the matter of classification. The natural way to classify a hybrid is to name the parents from which it has sprung. But such a classification is misleading unless the hybrid variety partakes of the characters of the parents to which it is referred. To be sure it is quite possible that a hybrid may have sprung from two given parents and still show the characters of neither. And though this would be an important fact, it is entirely aside from the matter of classification, and classification is of the greater importance. So that, whatever precautions may be necessary in studying the physiology of hybridity, the characterization and classification of hybrids depends on intermediateness of extrinsic characters alone.

As a matter of fact this is the sole basis of classification anyway; for although many people assume physiological and genealogical characters in their definitions of species, they disregard everything but external characters in species-making. Classification is, first of all, a systematic presentation of apparent resemblances and differences.



15. Leaf Margiin of Wyant, (representing Forest Garden), Pendent, Forewattamie and Pottawattamie. Pendent and Forewattamie are supposed hybrids between Forest Garden and Pottawattamie. Magnified.

It is necessary to dwell on this point here, for in the classification of hybrids the temptation is especially strong to obscure the value of the plant's visible attributes by bringing in divers irrelevant considerations.

A hybrid, then, is to be classified by referring it to the several species whose characters it exhibits. But different hybrids of the same parentage may exhibit their several characters in various combinations or in different degrees. It is the business of the pomologist to point out these different combinations and degrees in his descriptions. Another difficulty lies in the fact that, in a single series of hybrids, one variety may strongly resemble one parent, while another resembles the other more particularly, and this leads to difficulty, because it soon presents an unbroken chain of intergradient forms reaching from one specific type to the other. This is quite true, but the plant classifier who insists on having missing links to mark off his groups would better keep out of horticulture altogether!

This difficulty has already arisen in the classification of plums. It is especially exemplified in the great Hortulana tribe with its various subdivisions. As these plums are now supposed to present a vast congregation of hybrids (see page 22), they offer a case directly in point. The present writer has already shown* that these varieties fall into a long and scarcely broken series, which may be arbitrarily cut up into various subdivisions for convenience of study, though these subdivisions can never be separated from one another.

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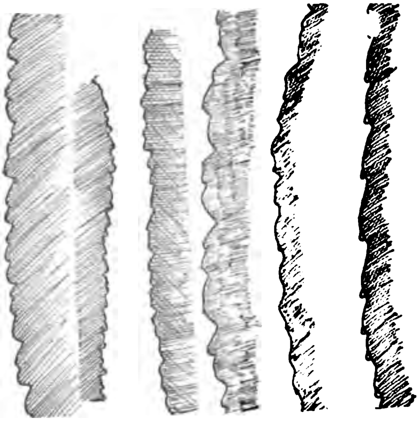
*See Vt. Exp. Sta. Rpt. 10, (1897), p. 104. Also Garden and Forest 10, (1897), p. 304.

A good classification, at least in such variable groups as those now under discussion, does not depend so much on the exactness with which boundary lines are traced as on the clearness with which certain dominant or central types are set forth. Thus we have the Wildgoose plum as the type of the Wildgoose group. This is something definite, tangible, though the boundary line between the Wildgoose group and the Chicasaws is quite as imaginary as that one which "passes around the earth midway between the poles."

The work of classifying plums thus falls into two parts. First one must fix in his mind certain definite types; and second, he must group the multitudinous varieties about these types, referring them to whatever type or types they seem most to resemble.

This is the ideal method, but it is especially necessary in the classification of hybrids or of groups in which the ordinary variations are very great. The introduction of this new factor, the hybrid plums, into pomology does not introduce a new factor into plum classification. No one need feel that all the pains spent in recent years in arranging horticultural varieties into lists under sundry botanical species will be lost, or that ultimate and inextricable confusion awaits us. We need only to keep more clearly in mind than before the ideal types which have been chosen, and if a given variety falls midway between two specific types it will be understood best by calling it a hybrid of the species represented.



16. Leaf Margins of Abundance, Scribner Lannix, Minnie, Ruby and Wildgoose. Abundance and Wildgoose are the supposed parents of the others. Note intermediate characters.

It is very important to have this matter clearly understood now when artificially produced hybrids are just beginning to come into notice.

### 3. EXTENT AND LIMITS OF HYBRIDITY IN PLUMS.

We have heard a great deal at one time and another about the limits of crossing between species and of the affinities of one species for others. If such limits and affinities exist, it is important that we should learn them. For their study no material is better than the results of experimental crossings. And though the number of hybrids thus far brought to light is sadly small for such a generalization, the urgency of the demand for information on this point may execuse a hasty survey of the present data in the hope that some slight prevision of the truth may reward us.

For this purpose the list of hybrids has been thorougly overhauled, those of very uncertain parentage have been thrown out, all those of parentage reaching outside the true plums have been discarded, and a few unpublished varieties have been added to those described on pages 5–22. The list so arranged numbered 30 varieties, of which the parentage is distributed as shown in the following table. For the purposes of this comparison *Prunus hortulana* is regarded as a separate species.

TABLE SHOWING THE DISTRIBUTION OF HYBRID PLUMS AMONG PARENT SPECIES.

| SPECIES | P. domestica | P. cerasifera | P. simoni | P. triflora | P. angustifolia | P. hortulana | P. americana |
|---|---|---|---|---|---|---|---|
| P. domestica | | | | 1 | | | |
| P. cerasifera | | | | 5 | 1 | | |
| P. simoni | | | | 5 | | | |
| P. triflora | 1 | 5 | 5 | | 10 | 5 | 1 |
| P. angustifolia | | 1 | | 10 | | | 2 |
| P. hortulana | | | | 5 | | | |
| P. americana | | | | 1 | 2 | | |
| Totals | 1 | 6 | 5 | 27 | 13 | 5 | 3 |

As already indicated these thirty varieties do not furnish an adequate basis for generalization, but nevertheless some of the figures in the table are worthy of remark. The first thing which strikes the eye is the very large number of hybrids having Japanese pedigrees. Twenty-seven, or 90 per cent of the whole list, are referred to this species. One explanation of this strange fact is that horticulturists have made special effort to secure Japanese hybrids, because they have felt that this line was one of unusual promise. But this is not the only reason. It seems fairly safe to conclude, even thus early, that the Japanese plums have a special affinity for the Chicasaws and for the closely related members of the Wildgoose group.

Another fact of interest in the foregoing table is the reference of only one hybrid to *Prunus domestica*. There has been a belief for sometime prevalent among fruit growers that the Domestica plums did not cross naturally with other species, and that hybrids were to be produced artifically only with extreme difficulty. This view is probably correct. The Americana plums also seem to have less affinity for the other species with which they are usually cultivated than do the Chicasaws, Hortulanas and Trifloras.

As to the absolute limits of possible cross-fecundation our ideas have been considerably extended. It may be considered settled that crosses can be effected, under favorable conditions, between any two species of plums. What is much more remarkable is the unquestionable fact that several of the cherries may be crossed with the plums. In the Compass cherry *Prunus besseyi* has been combined with Miner, which stands very near to the Americanas. In the Utah Hybrid *P. besseyi* has doubtless been united with *P. watsoni*. I have also had the opportunity to examine what seem to be satisfactory hybrids of *Prunus subcordata* X *P. triflora* and *P. maritima* X *P. besseyi*. Mr. Burbank last summer sent me two distinct and probably authentic hybrids between Satsuma plum and Belle Magnifique cherry. Theo. Williams of Nebraska is said to have a hybrid of Wildgoose plum with Dye House cherry. Orange's Cherry-Plum, so-called, introduced to the trade a few years ago, and originating in Florida, is perhaps a cherry-plum hybrid. Henry A. Brainerd of California has also raised two or three trees which seem to be true plum-apricot hybrids; and two famous cases of plum-peach hybrids are on record (see Blackman and Mule, p. 7 and 17.) T. V. Munson of Texas has reported a number of hybrids of Wildgoose plum with Alexandar peach.*

These strange facts furnish food for reflection, and tend to make one cautious in his predictions.

Another conclusion seems warranted from the facts thus far developed. This is that crossing in the plum orchard is altogether common. Thus we may depend on all sorts and species of plums for cross-pollination, and may expect to see great numbers of accidental hybrids brought to notice in the next few years.

### 4. UTILITY OF THE SEVERAL SPECIES IN HYBRIDIZING.

The introduction of accidental hybrids is likely to be supplemented in the immediate future by more extensive and systematic work in the production of hybrids by hand-pollination. This work is apt to be successful in proportion to the intelligence brought to bear on it. Any suggestions, therefore, as to the value of the several available species in the production of hybrids may be acceptable, though, like the other generalizations of this bulletin, they are put forth in a tentative manner only.

*Prunus domestica.*—This species is comparatively difficult to hybridize. It may be hoped, however, that it will give the very best of results. The solid, meaty flesh and the freestone character of leading Domesticas are especially desirable for combination with the higher flavor, better color, freer growth, healthier foliage, and other desirable qualities of native species. The writer looks with especial favor upon the combination of Domestica with Americana parents.

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*Country Gentleman 51, (1886), p. 972.

*Prunus cerasifera.*—During the preparation of this paper a considerable number of hybrids of this species were examined. Several of them appeared to be of value, but on the whole this species is not to be regarded as a promising one for use in hybridizations.

*Prunus simoni.*—"The best of all the plums in hybridizing," writes Mr. Burbank, and his results seem to justify him in the opinion. Although *Prunus simoni* itself is regarded by most horticulturists as a very worthless thing it seems to have a thoroughly respectable progeny. The peculiarly disagreeable taste which characterizes the parent seems never to be present in hybrid offspring. Instead one has a firm, meaty flesh, with a rich, sweet, sugary flavor. The size, color, and flesh of the Simon plum are all desirable, and though it is hardly probable that other hybridizers will have the same success with this species that Mr. Burbank has had, it has nevertheless fully proved itself worthy of consideration.

*Prunus triflora.*—The facility with which this species crosses with others, especially with *P. angustifolia*, has already been touched upon. The twenty-seven hybrids credited to it on page 27 form an interesting and important family. Crossing with the Chicasaws, however, seems inclined to give fruits with soft, stringy, watery flesh clinging to the stones. These are among the more undesirable characters of the Chicasaws, and might be wisely avoided by using other combinations. Although it is much more difficult to combine *P. triflora* with *P. americana*, the results are likely to prove much better.

*P. angustifolia.*—This species is discussed in the preceding paragraph as regards its combination with *P. triflora.* It ought to be combined with varieties having firm, meaty flesh and free stones.

*P. hortulana.*—The remark made in the paragraph above applies also to the Hortulanas. They are, however, to be regarded in general as more promising subjects of hybridization. They should be crossed with firm fleshed, free-stone sorts.

*P. americana.*—The finest flavor known in plums belongs unquestionably to the Americanas. The firmness of flesh and hardiness of tree are also qualities of paramount practical importance. Partly on account of their late blooming season, and partly perhaps on account of a lack of affinity for other species, they do not hybridize so readily in the orchard. For the same reasons they are not so convenient for the plant breeder. In spite of this they are among the most promising plums for the production of valuable hybrids.

Other species may possibly give valuable varieties in some cases, but no particular attention need be given them in the present chaotic state of our knowledge.

### 5. PLUM-GROWING AS AFFECTED BY THE HYBRIDS.

First of all let it be understood that the present discussion of hybrid plums is not a recommendation of them for orchard planting. No list of select varieties is given, and no single variety is awarded a general recommendation. No hybrid variety has yet shown its ability to take a place in commercial horticulture. No one has ever proved a right to a place in the family fruit garden. Several of the varieties described in this bulletin are of great interest and some promise, and may well be planted by the amateur who loves to experiment with new things. More than this cannot be said respecting the present value of the hybrid plums.

The hybrid plums are discussed here for the fullness of the promise which they give of good things to come. It is the deliberate belief of the writer that the introduction of the hybrid plums marks an epoch in plum culture. The results promise to be even more abundant and far-reaching than those which have flowed from the hybridization of our native grapes. This is a strong comparison.

It is fully determined that plum-cherry hybrids are possible. The production of a plum-cherry hybrid capable of cultivation on a commercial scale would be the most revolutionary event in the history of horticulture.

Another possibility in plum hybridization, which it is yet too early to realize, is the selection of improved progeny from second, third, fourth, and subsequent generations of hybridized stock. It is a well known general principle that the immediate product of a cross-pollination is not so likely to give something desirable as are the seedlings of the second, third and fourth generations from this primary hybrid. The hybridization "breaks the type" and gives a beginning to variation. Subsequent generations are likely to vary immensely, even without further crossing, and among these variations the plant breeder may expect to find his prizes. Mr. Burbank is the only plum breeder within my knowledge who has thus far acted upon this principle. His early results are very encouraging. Already I have examined a number of second-generation seedlings of one of his best known hybrid varieties, among which several seem to be great improvements on the parent variety. Other groups of second and third generation hybrids which I have examined give equally gratifying impressions.

Perhaps it would be well in closing to repeat the statement that, although we expect great things from the hybrid plums in the future, no known hybrid is herewith recommended for anything but experimental planting.

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# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 68

JANUARY, 1899

# INSPECTIONS OF MILK-TESTS AND FEEDING-STUFFS.

I. INTRODUCTORY STATEMENT.—Pages 33–34.
II. TEXT OF THE LAWS.—Pages 35-37.
III. ESSENTIALS OF THE LAWS.—Pages 37-38.

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## BURLINGTON, VT.

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# BULLETIN NO. 68,
# INSPECTIONS OF MILK-TESTS AND FEEDING-STUFFS.

BY J. L. HILLS.

## I. INTRODUCTORY STATEMENT.

Two measures were passed at the legislative session of 1898 which affect the relation of the station to the agricultural interests of the state. One of these (No. 81) throws certain safeguards around the milk-test system as practiced at creameries and cheese factories. The other (No. 83) provides for the inspection of the concentrated commercial feeding-stuffs sold in the state, being quite similar in its essential provisions and scope to the well-known "fertilizer law." The execution of the former enactment is vested in the superintendent of the dairy school of the University of Vermont and State Agricultural College. At present, however, the offices of superintendent of the dairy school and director of the station are held by one individual, and station publications form the most convenient medium of getting the facts concerning the law before the public. The enforcement of the feeding-stuffs law devolves expressly upon the station director.

The genesis of these acts is essentially as follows:

*Milk-test law.**—Much unrest has been manifest of late years in creamery circles, particularly among the patrons, touching the accuracy of the milk-test system as used throughout the state. Unsuccessful attempts were made at the session of 1896 to enact laws looking to its improvement. The Vermont Dairymen's Association discussed the matter at its conventions in 1897 and 1898 and appointed a legislative committee with power to act in its name. The committee corresponded widely, held meetings, one of which was attended by several creamery officers and patrons, and formulated, as a result of its work, a bill which became House Bill 208, and, later, Act No. 81 of the Laws of 1898. The bill was made narrow in its scope because five other bills had been or were to be introduced embodying other provisions which had been discussed. It was thought safer, moreover, to take too short rather than too long a step at the outset. The bill as passed does not call for expenditure of state funds, is not financially burdensome on managements or operatives and provides for expenses incurred and no more. The ideas which it embodies were approved by all of the many interested parties who expressed their views in the matter.

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* The act under discussion (No. 81) is entirely distinct in its origin and intent from the enactment (No. 82) passed at the recent session providing, among other things, for payment for milk at creameries and cheese factories on the basis of butter instead of butter-fat.

*Feeding-stuffs law.*—Governmental control of the quality of feeding-stuffs has been practiced in European countries for a long time. It has recently been introduced in the neighboring states of Maine and Massachusetts, and is contemplated in New Hampshire, Rhode Island and Delaware.

The arguments in favor of a state control of feeding-stuffs are briefly as follows:

1. The trade involves enormous sums. Approximately $3,500,000 a year is expended in Vermont for feeding-stuffs for domestic animals.

2. The feeding-stuffs sold are of many kinds, they often bear misleading names, and their selling prices are no certain index of their value as feeds.

3. Different feeding-stuffs vary largely in composition one from another while those of the same name may be widely apart in feeding values owing to the differences brought about by (a) variations in the composition of the material from which they are derived; (b) by differences or changes in methods of manufacture; (c) by adulteration.

4. Guaranteed compositions would tend to insure better values, wiser purchases and greater confidence. A feeding-stuff control would aid in money saving and be of distinct educational advantage.

All the arguments favoring a control of the sale of commercial fertilizers are applicable to the present case.

The Director of the Maine station states that "the most noticeable thing accomplished by the law is the driving out of the state the adulterated cottonseed meal which was so largely sold in 1897. The inspection law has driven it to other states." The chief chemist of the Rhode Island station says "I regret to say that Rhode Island is becoming the dumping ground of adulterated cottonseed meal, etc." The Maine law has been found in experience to "protect both the dealer and the consumer" and to "tend toward a more rational use of feeding-stuffs, which will be alike beneficial to the feeder and the dealer." The chemist of the Massachusetts station states that "while fully one-third of all samples of cottonseed meal received at this station during 1897 proved to be seriously adulterated, thus far in 1898 not a single adulterated article has been discovered." He also says that "the inspection shows the feed-stuffs to be comparatively free from serious adulteration. Some show rather wide variations in composition, which it is hoped will be corrected in the future." Also "a great variety of oat refuse is now finding its way into our markets. It has been found to contain from 35 to nearly 60 per cent of hulls . . . farmers are cautioned against paying excessive prices for material of this kind." This law was proving so satisfactory in other states that there seemed good reason to believe that it would work well in Vermont. The general idea received the warm endorsement of the State Board of Agriculture and the Vermont Dairymen's Association. Like the milk-test law it calls for no appropriation from the state but pays its own bills, all excess of income over expenditure being covered into the state treasury.

## II. TEXT OF THE LAWS.

The text of the laws are as follows:

### No. 81.

### AN ACT FOR THE PROTECTION OF DAIRYMEN, RELATING TO TESTING MILK AND CREAM.

It is hereby enacted by the General Assembly of the State of Vermont:

Section 1. All bottles, pipettes or other measuring glasses used by any person, firm or corporation, or their agents or employees, at any creamery, butter factory, cheese factory, or condensed milk factory, or elsewhere in this State, in determining by the Babcock test, or by any other test, the value of milk or cream received from different persons or parties at such creameries or factories, shall, before such use, be tested for accuracy of measurement and for accuracy of the per cent. scale marked thereon. It shall be the duty of the superintendent of the dairy school of the University of Vermont and State Agricultural College to designate some competent person to test the accuracy of such bottles, pipettes or other measuring glasses. The person thus designated shall so mark such bottles, pipettes or other measuring glasses as are found correct in marks or characters which cannot be erased, which marks or characters shall stand as proof that they have been so tested; and no incorrect bottles, pipettes or other glasses shall be thus marked. The superintendent of the dairy school shall receive for such service the actual cost incurred and no more, the same to be paid by the persons or corporations for whom it is done.

Section 2. Each and every person who, either for himself or in the employ of any other person, firm or corporation, manipulates the Babcock test, or any other test, whether mechanical or chemical, for the purpose of measuring the contents of butter fat in milk or cream as a basis for apportioning the value of such milk or cream, or the butter or cheese made from the same, shall secure a certificate from the superintendent of the dairy school of the University of Vermont and State Agricultural College that he or she is competent and well qualified to perform such work. The rules and regulations in the application for such certificate and in the granting of the same shall be such as the superintendent of the school may arrange. The fee for issuing such certificate shall in no case exceed one dollar, the same to be paid by the applicant to the superintendent of the dairy school and be used by the superintendent in meeting the expenses incurred under this section.

Section 3. Any person or persons violating any of the provisions of this act, shall, on conviction in a court of competent jurisdiction be fined not more than twenty-five dollars for the first offence, and not more than fifty dollars for each subsequent offence. It shall be the duty of every sheriff, deputy sheriff and constable to institute complaint against any person or persons violating any of the provisions of this act, and, on conviction, one-half of the fines shall go to the complainant and the balance to the State.

Approved November 19, 1898.

### No. 83.

### AN ACT TO REGULATE THE SALE OF CONCENTRATED COMMERCIAL FEEDING-STUFFS.

It is hereby enacted by the General Assembly of the State of Vermont:

Section 1. Every lot or parcel of any concentrated commercial feeding stuff, as defined in section three of this act, used for feeding farm live stock, sold, offered or exposed for sale in the state of Vermont, shall, in addition to the tax tag described in section five of this act, have affixed thereunto, in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds of feeding-stuff in a package, the name, brand or trade mark under which the article is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentages it contains, of crude protein, allowing one per cent. of nitrogen to equal six and one-fourth per cent. of protein, and of crude fat, both constituents to be determined by the methods adopted at the time by the Association of Official Agricultural Chemists; provided that the statement of the percentage of crude fat may be omitted if it does not exceed three per cent.

Section 2. The term concentrated commercial feeding-stuff, as here used, shall not include hays and straws, the whole seed nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn. Neither shall it include wheat, rye and buckwheat brans or middlings, nor pure grains ground together, nor wheat bran or middlings mixed together or with other feed.

Section 3. The term concentrated commercial feeding-stuff, as here used, shall include linseed meals, cottonseed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, ground beef or fish, mixed feeds, provenders, and all other materials of a similar nature not included within section two of this act.

Section 4. Before any concentrated commercial feeding-stuff, as defined in section three of this act, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offers it for sale within the State of Vermont, shall, for each and every feeding-stuff bearing a distinguishing name and trade mark, file with the director of the Vermont Agricultural Experiment Station a certified copy of the statement named in section one of this act, and shall also deposit with said director, at his request, a sealed glass jar or bottle containing not less than one pound of the feeding-stuff to be sold or offered for sale, accompanied by an affidavit that it is a fair average sample thereof and corresponds within reasonable limits to the feeding-stuff which it represents in the percentage of protein and fat which it contains.

Section 5. The manufacturer, importer, agent or seller of each concentrated commercial feeding-stuff as defined in section three of this act, shall, before the article is offered for sale, pay to the director of the Vermont Agricultural Experiment Station an inspection tax of ten cents per ton for each ton of such concentrated feeding-stuff sold or offered for sale in the State of Vermont, and shall affix to each car shipped in bulk and to each bag, barrel or other package of such concentrated feeding-stuff, a tag to be furnished by said director, stating that all charges specified in this section have been paid. The director of said experiment station is hereby empowered to prescribe the forms for such tags, and adopt such regulations as may be necessary for the enforcement of the law. Whenever the manufacturer or importer or shipper of a concentrated feeding-stuff shall have filed the statement made in section one of this act and paid the inspection tax, no agent or seller of said manufacturer, importer or shipper shall be required to file such statement or pay such tax. The amount of inspection tax received by said director shall be paid by him to the state treasurer. So much of the inspection tax collected under this act shall be paid by the state treasurer to the treasurer of said experiment station as the director of said experiment station may show by his bills has been expended in performing the duties required by this act, but in no case to exceed the amount of the inspection tax received by the state treasurer under this act, such payment to be made quarterly upon the order of the auditor of accounts, who is hereby directed to draw his order for such purpose.

Section 6. Any manufacturer, importer, agent or person selling, offering or exposing for sale any concentrated commercial feeding-stuff, as defined in section three of this act, without the statement required by section one and the tax tag required by section five of this act, or with a label stating that said feeding-stuff contains substantially a larger percentage of either the constituents mentioned in section one than is contained therein, shall on conviction in a court of competent jurisdiction be fined not more than fifty dollars for the first offense, and not more than one hundred dollars for each subsequent offense.

Section 7. All manufacturers and importers of concentrated commercial feeding-stuffs, or dealers in the same, shall, when requested, furnish the director of the Vermont Agricultural Experiment Station with a complete list of the names or trade marks of said feeding-stuffs, and all agents selling, offering or exposing the same for sale.

Section 8. The director of the Vermont Agricultural Experiment Station shall cause one analysis or more to be made annually of each concentrated commercial feeding-stuff sold or offered for sale under the provisions of this act. Said director is hereby authorized in person or by deputy to take a sample not exceeding two pounds in weight for analysis from any lot or package of concentrated commercial feeding-stuff which may be in the possession of any manufacturer, importer, agent or dealer in this state; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and shall be taken from a parcel or number of packages which shall not be less than five per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass or metal vessels, carefully sealed, and a label placed on each stating the name or brand of the feeding-stuff or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing, and said label shall be signed by the director or his deputy and by the parties or party in interest, or their representative, present at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled, and the sample or samples retained by the director shall be for comparison with the certified statements named in sections one and four of this act. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise shall be published in reports or bulletins from time to time.

Section 9. The Director of the Vermont Agricultural Experiment Station shall notify the state treasurer of all violations of this act, and the state treasurer shall commence a suit in the name of the state against the party or parties thus reported. It shall be the duty of the treasurer upon ascertaining any violation of this act to forthwith notify the manufacturers and importers, in writing, and to give them not less than thirty days thereafter in which to comply with the requirements of this act. But there shall be no prosecution in relation to the quality of any concentrated commercial feeding-stuff if the same shall be found to be substantially equivalent to the statement of analysis made by the manufacturers or importers.

Section 10. The term importer, for all the purposes of this act, shall be taken to mean all who procure or sell concentrated commercial feeding-stuffs.

Section 11. All acts or parts of acts inconsistent with this act are hereby repealed.

Section 12. This act shall take effect July 1st, 1899.

Approved November 29, 1898.

## III. ESSENTIALS OF THE LAWS.

The essential points of these laws may be concisely stated as follows:

*Milk test law.* Section 1 provides that all Babcock glassware *used in dividend making* at creameries, cheese factories, etc., shall be tested as to accuracy by some competent person, the same, when tested and found accurate, to be indelibly marked as proof of correctness, the cost of such testing and marking to be paid by the parties for whom the work is done.

Section 2 provides that all operatives of the Babcock test *used in dividend making* at creameries, cheese factories, etc., shall secure certificates setting forth their ability to analyze milk accurately, the same to be issued on proof of such ability and under such rules and regulations as may be prescribed, the fee for the certificate not to exceed one dollar.

Section 3 is a penal section.

*Feeding-stuffs law.* Section 1 provides that all packages of "concentrated commercial feeding-stuffs" sold in Vermont shall bear a statement of the weight, name of goods, name and address of manufacturer and percentages of crude protein and of crude fat.

Sections 2 and 3 respectively define what materials are not and what are held to be, for the purposes of the law, "concentrated commercial feeding-stuffs."

Sections 4 and 7 provide for filing copies of guaranteed analyses, lists of feeds offered and agents selling same, by the manufacturers at the director's request.

Section 5 provides that the "manufacturer, importer or seller" (the latter two only in case the manufacturer fails to comply with the law,) shall pay to the director a tax of 10 cents a ton to cover costs of inspection and shall affix to each package a tag to be furnished by the director, stating that all charges have been paid; empowers the director to make regulations in the enforcement of the law; provides for the payment of its receipts to the state treasurer and for the reimbursement of the station for expenses incurred, these in no case to exceed the total receipts under the law.

Section 6 is a penal section.

Section 8 provides for the sampling of the material in the hands of the seller; also that one or more analyses of each goods be made annually and the results thereof published together with such additional information as seems advisable.

Section 9 prescribes action in case of violation and defines violation of the act so far as it relates to the quality of the goods.

Section 10 defines the word "importer."

Section 11 is a repealing section.

Section 12 states that "this act shall take effect July 1, 1899."

The rules and regulations concerning the milk-test law will be sent to such parties as may be interested on application to the "Superintendent of the Dairy School, Burlington, Vt."

The regulations touching the feeding-stuffs law will concern manufacturers, importers and sellers only. These will be made from time to time as occasion warrants. Correspondence touching these should be addressed to the Experiment Station, Burlington, Vt.

It is expected to make all regulations and rulings under the laws as slightly onerous as possible without defeating the ends sought.

*It is earnestly requested that failures to comply with any of the provisions of either enactment be reported to the station, in order that their enforcement may be facilitated and the public good be advanced.*

*Note concerning milk-test law.* 5329 pieces of Babcock glassware have been tested to date (Feb. 1), 2148 new (hitherto unused), 3181 old (already used). 39 of the former and 111 of the latter were found incorrect, 1.8 and 3.5 per cent of error respectively. One out of every 28 pieces of old apparatus and one out of every 55 pieces of new apparatus proved to be wrong. Several very bad bottles and two very bad lots of bottles have been found. Correct apparatus is stamped indelibly VT. EX. ST., incorrect apparatus is indelibly stamped BAD.

There have been 115 applications for licenses received to date, 45 of which have been granted and 3 refused, while in 67 cases examinations are still incomplete.

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# UNIVERSITY OF VERMONT
# AND STATE AGRICULTURAL COLLEGE

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## VERMONT AGRICULTURAL
# EXPERIMENT STATION
## BURLINGTON, VT.

# BULLETIN No. 69

## MARCH, 1899

# Analyses of Commercial Fertilizers

I. STATEMENT REGARDING ANALYSES—Page 41.
II. SCHEDULE OF TRADE VALUES—Pages 41–46.
III. OBSERVANCE OF THE FERTILIZER LAW—Page 47.
IV. LICENSED FERTILIZERS SAMPLED BY STATION—Pages 48–50.
V. ANALYSES OF LICENSED FERTILIZERS—Pages 51–53.

**NOTICE.**--Bulletin 67 on "Hybrid Plums," being technical in its nature, will not be sent out to the entire mailing list. It will be sent without charge to any one applying for it. Address Experiment Station, Burlington, Vt.

BURLINGTON:
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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the East.

# BULLETIN NO. 69.

# ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills, C. H. Jones and B. O. White.

## I. STATEMENT REGARDING ANALYSES.

The present bulletin contains analyses of 36 samples of leading brands of goods licensed for sale in Vermont. Usually composite samples (mixtures of equal portions of two or more samples of the same brand taken at different points) have been analyzed, but in some cases single samples only have been taken.

The choice of brands for immediate analysis and early publication is based largely upon the frequency with which they have been found in the search for samples during the five past as well as during the present season, this being regarded as an indication of comparatively extended use.

A second bulletin of analyses will be issued about April 30th, in which it is expected to include all the brands most commonly sold in the state. A third will be issued late in May and will contain the analyses of the brands less widely used, together with a reprint of the analyses given in the March and April bulletins.

All samples are taken by agents of the experiment station from this year's shipments in the hands of local dealers, and represent therefore exactly what the purchaser is getting.

For detailed data regarding the meaning of the terms used in fertilizer analysis, the principles underlying the use of fertilizers, the elements of plant food, the sources of crude stock or raw materials used in manufacture, the commercial and agricultural values of fertilizers, the arguments in favor of and methods of home-mixing, the rational and economical selection, purchase and use of fertilizers, the reader is referred to bulletins 47 and 65 ot this station which will be sent to any address upon application.

## II. SCHEDULE OF TRADE VALUES.

The following schedule of trade values to be used in this state in 1899 is the one agreed upon by the experiment stations of Massachusetts, Rhode Island, Connecticut, New Jersey and Vermont, after a careful study of prices ruling in the large markets of the southern New England and middle states. For comparative purposes the schedule used last year is included in the tabulation.

### TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1898 AND 1899.

| | 1898 cts. per lb. | 1899 cts. per lb. |
|---|---|---|
| Nitrogen in ammonia salts | 14 | 15 |
| “ in nitrates | 13 | 12½ |
| Organic nitrogen in dry and fine ground fish, blood and meat and in mixed fertilizers | 14 | 14 |
| “ “ in fine ground bone and tankage | 13½ | 14 |
| “ “ in coarse bone and tankage | 10 | 10 |
| Phosphoric acid soluble in water | 4½ | 4½ |
| “ “ “ in ammonium citrate* | 4 | 4 |
| “ “ in fine ground bone and tankage | 4 | 4 |
| “ “ in coarse bone and tankage | 3½ | 2 |
| “ “ insoluble (in water and in ammonium citrate) in mixed fertilizers | 2 | 2 |
| Potash as high grade sulphate and in mixtures free from muriate (or chlorids) | 5 | 5 |
| Potash as muriate | 4¼ | 4¼ |

The above trade values are, as nearly as can be estimated, the average figures at which, in the six months preceding March 1st, the respective ingredients could be bought at retail for cash in the larger markets, (Boston, New York, etc.,) in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st, plus about 20† per cent in the case of goods for which there are wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable average retail price in the large markets of standard raw materials such as sulphate of ammonia, nitrate of soda, muriate of potash, sulphate of potash, dried blood, plain superphosphate, (acid phosphate), azotin, ammonite, dry ground fish, cottonseed meal, bone, tankage and ground South Carolina or Florida rock.

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*Dissolved from 2 grams of the unground phosphate, previously extracted with pure water, by 100 c. c of a neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes at 65 degrees C., with agitation once in five minutes; commonly called "reverted," or "backgone" phosphoric acid.

†Except in case of available phosphoric acid which has been purchased during the past two years at several points, particularly in the middle states, at very low prices. The "plus" in the case of this ingredient is far above 20 per cent.

### APPLICATION OF TRADE VALUES TO SUPERPHOSPHATES AND MIXED GOODS.

The above trade values are applied to the valuation of superphosphates and mixed goods as follows:

The organic nitrogen is valued at 14 cents a pound, it being assumed that it is obtained from such materials as dried blood, high grade tankage, cottonseed meal, ground fish or nitrogenous substances of equally good quality.

Nitrogen in the form of nitrate of soda and sulphate of ammonia is valued at 12½ and 15 cents a pound respectively.

Soluble, reverted and insoluble phosphoric acids in mixed fertilizers are valued 4½, 4 and 2 cents a pound respectively.

Potash is valued at 4¼ cents a pound, the price of that ingredient in kainit and muriate, if there is sufficient chlorin in the fertilizer to unite with all the potash; if not, such as is not thus united is valued at 5 cents a pound, the price of that ingredient in high grade sulphate.

The "station valuation" of a fertilizer may be obtained by *multiplying the given per cent of each constituent (nitrogen, soluble, reverted and insoluble phosphoric acids and potash) by its trade value, adding the products and multiplying the sum by 20.*

### COMMERCIAL VALUE OF COMMERCIAL FERTILIZERS.

In order that there may be no misconception and that the reader may clearly appreciate what these valuations are and what they are not, it is our custom to call attention repeatedly to the fact that **the station valuation of a brand of fertilizer does not represent its proper selling price at the point of consumption**. Neither should it be inferred that the ingredients in the brand in question have of necessity the commercial value indicated. It may be greater or less than is shown. The station does not pretend dogmatically to state the commercial worth or valuation of any given fertilizer. Its "valuations" should be construed as showing the *retail trade value or cash-cost of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in unmixed standard raw materials of good quality, at the seaboard.*

The following explanations may serve to render these points yet more clear.

1. The trade values scheduled on page 42 of this bulletin represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, respectively, can now be purchased, in their various forms, for cash, at retail, in the large markets of the southern New England and the middle states. They are based in part upon the ton prices at which certain classes of goods are offered to actual consumers by manufacturers and brokers, and

in part upon the wholesale prices as quoted during the six months preceding March 1st, plus 20* per cent.

2. These trade values do not include the charges for mixing, bagging, storage, freight, commissions to agents and dealers, selling on long credit, bad debts, interest on investment, depreciation of plant, profits, etc.

They represent the retail prices of nitrogen, phosphoric acid and potash, at the seaboard (Boston, New York, etc.) singly and unmixed. In ordinary complete fertilizers the three ingredients are mixed together, but this is not a necessary condition of their use. In their unmixed condition they are ready for use by the farmer, if it is desired to apply them separately.

An illustration may serve to make the above statements more clear. A farmer wishes a ton of fertilizer similar to the well-known brands sold in this state. If he purchases in Boston or New York fifty (50) pounds of nitrate of soda, three hundred and fifty (350) pounds of dried blood, one hundred and twenty-five (125) pounds of muriate of potash and fourteen hundred and seventy-five (1475) pounds of dissolved South Carolina rock, known in the trade as "acid phosphate" and mixes these ingredients together, he will have a complete fertilizer analyzing much the same as the average goods sold in Vermont in 1898 and not essentially different (chemically) from many standard brands now in the market.

The cost of the ton after mixing (if the farmer prefers to mix the ingredients himself) will be made up as follows:

(*a*) Cost of the materials in the markets.

(*b*) Cost of transportation.

(*c*) Cost of mixing.

The first item (*a*) entering into the total cost is the only one included in the "valuation." If there is added to this one item not only the charges for transportation and mixing but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary complete fertilizers, when delivered at or near the place of consumption. It is clear, therefore, that the selling price at the point of consumption must of necessity exceed the "valuation," the excess representing the manufacturer's charges for converting raw materials into finished products, for freighting and for selling them.

Since the cost of mixing and selling must of necessity vary somewhat with different companies, and since freight rates to the different sections of the state are quite unlike, it is unsafe to assign any arbitrary sum to cover these charges. These can be best estimated by the consumer to fit his local conditions.

"Valuations" may be found useful:

(*a*) To show whether a given fertilizer is worth its cost from the *commercial* standpoint.

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*See foot note † page 42.

(*b*) As a common basis on which to compare the *commercial* values of different brands, enabling buyers to note whether prices asked are warranted by values contained.

In 1898 the average selling price of 126 brands sold in Vermont, was $29.04 per ton, the average "valuation," $17.86, and the difference $11.18, an advance of 63 per cent on the "valuation." Or, stating the case in another, and, perhaps, a clearer way, on the average two dollars out of every five were paid for expenses, while three of the five dollars were paid for the plant food.[*] Amounts of plant food of the best quality equal to what was contained in several brands might have been bought at retail for cash at the seaboard for less than one-half the credit price asked in Vermont; in one case 39 cents might have bought as much as did a dollar.

Selling prices always exceed valuations, since the latter show only seaboard values of unmixed ingredients and do not include the other necessary and legitimate charges already mentioned which accompany the manufacture and sale of mixed goods. If the selling price does not exceed the valuation more than 30 to 40 per cent it may not be too high, but in proportion as the excess increases beyond this point there is reason to question the economy of the purchase.

It is usually found that the low-priced brands are, commercially, the most costly. Last year's inspection developed the following facts:

1. The same amounts of plant food which cost a dollar in the average low priced brands (below $28) might have been bought in the unmixed state at retail and at the seaboard for 58 cents; in the average medium priced goods ($28 to $32) for 60 cents; and in the average high-priced goods ($32.50 and upwards) for 67 cents. Extremes of values were 79 cents and 39 cents. In 20 per cent of the entire number of brands the charges for manufacture, sale, etc., were almost as great as or greater than the retail seaboard value of the plant food.

2. In over one-third of the number of low-priced goods, charges for mixing, sale, etc., aggregated at least 45 per cent of the selling price, while in but one-sixth of the total number of medium priced brands and in none of the high-priced goods were the costs as high as 45 per cent.

3. Seventy per cent of the total number of high-class goods contained an equivalent of 65 cents or more worth of plant food at retail seaboard prices, while only 19 per cent of the medium grades and 17 per cent of the low-priced brands contained as high a relative value.

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[*] An illustration of the method of making this latter comparison may prove helpful. A brand of fertilizer containing 2 per cent of nitrogen, 9 per cent of total phosphoric acid, 7 per cent of soluble phosphoric acid, 1 per cent reverted phosphoric acid, 1 per cent of insoluble phosphoric acid, and 6 per cent of potash sells at consumer's depot for $28. In the absence of analysis the minimum guarantee may be taken as a basis of calculating "valuation," which is found to be $18.20. $18.20 ÷ $28 = 0.65 A dollar buys 65 cents worth of plant food and 35 cents is paid for manufacture, transportation and selling expenses.

Low grade brands cost relatively high prices because the expenses of manufacture and sale are equally as great as and proportionately greater than those on high class goods. The companies as a rule prefer to sell the better goods, but there is a wide-spread popular demand for low-priced fertilizers, a desire "to get a lot for the money." General and local agents report difficulty in selling the higher grades, which must usually prove more satisfactory because of the greater economy of purchase and the greater likelihood that first-class materials are used in manufacture.

### AGRICULTURAL VALUE OF COMMERCIAL FERTILIZERS.

It often occurs that consumers lay too much stress upon the "valuation" and too little upon the analysis. The valuations stand in no direct or necessary relation to the comparative profits which may result from the use of the various brands. Their significance is almost purely commercial.

Buyers should remember that high class goods, giving relatively large values of plant food for the dollar invested, are usually rich in nitrogen, the most costly of the three ingredients. The dairy farmer need not buy this element in large quantities in his fertilizers. If he buys concentrated feeds, if he is using absorbents and gypsum in the stable, if he prevents the manurial losses caused by fermentation and leaching, and if he gets his manure promptly upon the soil, he is usually supplying most of the needed nitrogen. Some of this element, however, may be wanted in the more readily available forms as found in commercial fertilizers as a starter. Such a man usually needs to buy relatively little nitrogen, yet, notwithstanding, should get at least 65 or better, 70 cents worth of plant food for a dollar.

Among the points bearing upon economical and rational purchase, other than the relation of the selling price to the value of the plant food contained, and the advisability of "fertilizing by feeding," may be cited :

1. Previous experience obtained personally or by careful, observing, reliable neighbors with similar goods on the same or similar soil with the same crops.
2. Reputation of the firm offering the goods.
3. The advantages and disadvantages of home mixing as compared with the purchase of "mixed goods."
4. The character and amount of barn-yard manure on hand.
5. The character, previous cropping and manuring of the soil.
6. The demands of the crop upon the plant food of the soil.
7. The analysis of the goods under consideration and its fitness for soil, crop, and as a supplement to home manurial supplies.
8. The forms in which the ingredients occur ; nitrogen as nitrates organic matter, etc., potash as muriate, as sulphate, etc.

## III. OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not affected by the restrictions of the law.

| License Number | NAME OF COMPANY | ADDRESS |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | Box 3404, Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | Box 3404, Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | P. O. Drawer 142, Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co., | State St., and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133–137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 92 State St., Boston, Mass. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 17 | H. J. Baker & Bro | 93–97 William St., New York, N. Y. |
| 18 | Russia Cement Co | Gloucester, Mass. |

### EXPLANATION OF THE TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers upon pages 51–53 show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 42 of this bulletin, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicized* type gives *guarantees*, the **black-face** type gives the **most important figures found by analysis.**

## IV. LICENSED FERTILIZERS SAMPLED BY STATION.

### Bowker Fertilizer Co., Boston, Mass.

**A2. Potash or Staple Phosphate**; from stocks of H. H. Meader, Marshfield; F. A. Kezer, Fletcher.

**A1. Vermont Grange Chemicals, D Brand**; from stocks of H. H. Meader, Marshfield; F. A. Kezer, Fletcher.

### Bradley Fertilizer Co., Boston, Mass.

**A5. Corn Phosphate**; from stocks of C. S. Richmond Co., Northfield; L. D. Nute, Marshfield.

**A13. Eclipse Phosphate for all Crops**; from stocks of L. D. Nute, Marshfield; H. B. Parkhurst, North Troy.

**A12. Potato Fertilizer**; from stocks of L. D. Nute, Marshfield; C. S. Richmond Co., Northfield.

**A4. Vermonter for all Crops**; from stocks of L. D. Nute, Marshfield; C. D. Richmond Co., Northfield.

**A3. XL-Superphosphate of Lime**; from stocks of L. D. Nute, Marshfield; D. A. Spooner, Randolph.

### Cleveland Dryer Co., Boston, Mass.

**A10. Potato Phosphate**; from stocks of J. H. Chaffee, Enosburgh Falls; D. A. Spooner, Randolph.

### E. Frank Coe Co., New York. N. Y.

**A7. Columbian Corn Fertilizer**; from stocks of Miles, McMahon & Co., Stowe; R. J. Gates, Franklin; H. B. Howard, Underhill.

**A6. Columbian Potato Fertilizer**; from stocks of Miles, McMahon & Co., Stowe; R. J. Gates, Franklin.

**B16. New England Potato Special**; from stocks of H. B. Howard, Underhill; R. J. Gates, Franklin.

### Crocker Fertilizer & Chemical Co., Buffalo, N. Y.

**A14. Ammoniated Corn Phosphate**; from stocks of C. A. Halebut, Richford; Wm. Richmond, Newport.

**A15. Potato, Hop and Tobacco Phosphate**; from stocks of Wm. Richmond, Newport; E. A. Adams, Coventry.

### Cumberland Bone Phosphate Co., Boston, Mass.

**B14. Potato Fertilizer**; from stocks of W. Pierce, Plainfield; A. A. Goodell, South Windham; Frank Wheelock, Newport; M. Boomhower, Hyde Park.

**A16. Superphosphate**; from stocks of W. Pierce, Plainfield; Frank Wheelock, Newport.

### Great Eastern Fertilizer Co., Rutland, Vt.

**B12. General Fertilizer**; from stocks of F. T. Hutchinson, Montpelier; S. Mills, Newbury; T. G. Bronson, East Hardwick.

**B13. Northern Corn Special**; from stock of T. G. Bronson, East Hardwick.

### Lister's Agricultural Chemical Works, Newark, N. J.

**A9. Special Potato Fertilizer**; from stocks of H. E. Shaw, Stowe; C. L. Hodges, Randolph.

**A8. Success Fertilizer**; from stocks of H. E. Shaw, Stowe; C. L. Hodges, Randolph.

### Lowell Fertilizer Co., Boston, Mass.

**B6. Swift's Bone Fertilizer for Corn and Grain**; from stocks of Burt Bros., Enosburgh Falls; E. A. Carrow, Coventry; Edw. Slayton, North Hartland.

**B7. Swift's Dissolved Bone and Potash**; from stocks of Burt Bros., Enosburgh Falls; W. E. Bailey, Newbury.

**B8. Swift's Animal Brand for all Crops**; from stocks of W. E. Bailey, Newbury; Edw. Slayton, N. Hartland.

**A11. Swift's Potato Phosphate**; from stocks of Burt Bros., Enosburgh Falls; E. A. Carrow, Coventry.

### Pacific Guano Co., Boston, Mass.

**B11** **Soluble Pacific Guano**; from stocks of D. Houston, Stowe; W. M. Murphy, Brattleboro.

### Quinnipiac Co., Boston, Mass.

**B5**. **Climax Phosphate for all Crops**; from stocks of L. B. Marble, Woodstock; W. S. Holland, Townshend; W. M. Batcheller, Newfane; J. K. Blaisdell, Pompanoosuc; E. E. Harris & Co., Morrisville.

**B3.** **Corn Manure**; from stocks of L. B. Marble, Woodstock; W. S. Holland, Townshend; J. H. Nelson, Ryegate; J. K. Blaisdell, Pompanoosuc.

**B4.** **Potato Phosphate**; from stocks of L. B. Marble, Woodstock; W. S. Holland, Townshend; J. H. Nelson, Ryegate; E. E. Harris & Co., Morrisville.

### Read Fertilizer Co., New York, N. Y.

**B20.** **Leader Guano**; from stocks of Warner Bros., Swanton; Chas. Kelton, Glover.

**B18**. **Practical Potato Special**; from stock of Warner Bros., Swanton.

**B17**. **Sampson for Potatoes**; from stocks of J. K. Brock, Ryegate; E. E. Putnam, South Newbury; R. E. Beard, East Barre.

**B19**. **Standard Superphosphate**; from stocks of Warner Bros. Swanton; Chas. Kelton, Glover.

### Russia Cement Co., Gloucester, Mass.

**B1.**. **Essex Complete Manure for Corn, Grain and Grass**; from stock of A. D. Loop, Hartland.

**B2**. **Essex Complete Manure for Potatoes and Roots**; from stock of A. D. Loop, Hartland.

### Henry F. Tucker Co., Boston, Mass.

**B15.** **Imperial Bone Superphosphate for Corn**; from stocks of A. W. Estey, Coventry; A. C. Larrabee, Berkshire.

### Williams & Clark Fertilizer Co., Boston, Mass.

**B9.** **Americus Potato Manure**, from stocks of S. H. Pearson, Coventry; Valley Grain Co., Brattleboro.

**B10**. **Royal Bone Phosphate**; from stocks of Valley Grain Co., Brattleboro; C. H. Willard, 2nd, Townshend.

## V. ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| A 2... | Bowker's Potash or Staple Phosphate | 0.19 | ...... | 0.64 | **0.83** | *0.82* | $2.27 | 3.71 | 4.04 | 2.67 | **10.42** | *10.* | **7.75** | *8.* | $7.64 | **3.14** | *3.* | $2.67 | A 2 |
| A 1... | Bowker's Vt. Grange Chem. D Brand | 0.88 | ...... | 1.63 | **2.51** | *2.06* | 6.76 | 4.47 | 3.07 | 2.44 | **9.98** | *9.* | **7.54** | *8.* | 7.43 | **4.01** | *3.* | 3.41 | A 1 |
| A 5... | Bradley's Corn Phosphate............ | ...... | ...... | 2.09 | **2.09** | *2.06* | 5.85 | 4.77 | 4.28 | 2.51 | **11.56** | *10.* | **9.05** | *9.* | 8.72 | **1.60** | *1.5* | 1.36 | A 5 |
| A 13.. | Bradley's Eclipse Phosphate.......... | 0.17 | ...... | 1.23 | **1.40** | *1.* | 3.87 | 5.14 | 3.94 | 3.27 | **12.35** | *12.* | **9.08** | *10.* | 9.09 | **1.61** | *1.5* | 1.37 | A 13 |
| A 12.. | Bradley's Potato Fertilizer............ | 0.19 | ...... | 1.97 | **2.16** | *2.06* | 6.00 | 4.79 | 3.93 | 2.51 | **11.23** | *11.* | **8.72** | *9.* | 8.46 | **3.51** | *3.25* | 2.98 | A 12 |
| A 4... | Bradley's Vermonter for all Crops... | 0.28 | ...... | 1.92 | **2.20** | *2.06* | 6.08 | 4.84 | 3.87 | 2.06 | **10.77** | *10.* | **8.71** | *8.* | 8.28 | **3.52** | *3.5* | 2.99 | A 4 |
| A 3... | Bradley's XL Superphosphate......... | 0.47 | ...... | 1.97 | **2.44** | *2.5* | 6.69 | 6.58 | 2.61 | 1.90 | **11.09** | *11.* | **9.19** | *9.* | 8.77 | **2.20** | *2.* | 1.87 | A 3 |
| A 10.. | Cleveland Potato Phosphate............ | 0.23 | ...... | 1.76 | **1.99** | *2.06* | 5.51 | 5.15 | 3.83 | 3.42 | **12.40** | *10.* | **8.98** | *8.* | 9.06 | **3.01** | *3.* | 2.56 | A 10 |
| *A 7... | Coe's Columbian Corn Fertilizer...... | ...... | 0.13 | 1.14 | **1.27** | *1.2* | 3.58 | 5.90 | 3.53 | 2.39 | **11.82** | *10.5* | **9.43** | *8.5* | 9.09 | **2.66** | *2.5* | 2.66 | A 7 |
| *A 6... | Coe's Columbian Potato Fertilizer... | ...... | 0.12 | 1.13 | **1.25** | *1.2* | 3.52 | 6.39 | 3.08 | 1.99 | **11.46** | *10.5* | **9.47** | *8.5* | 9.02 | **2.53** | *2.5* | 2.53 | A 6 |
| B 16.. | Coe's N. E. Special for Potatoes....... | ...... | ...... | 0.84 | **0.84** | *0.8* | 2.35 | 6.03 | 2.88 | 1.55 | **10.46** | *8.5* | **8.91** | *7.* | 8.36 | **3.23** | *3.* | 2.75 | B 16 |
| A 14.. | Crocker's Ammo. Corn Phosphate... | ...... | ...... | 2.03 | **2.03** | *2.* | 5.68 | 6.43 | 3.18 | 2.42 | **12.03** | *11.* | **9.61** | *10.* | 9.30 | **1.71** | *1.6* | 1.45 | A 14 |

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## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total Found | Total Guaranteed | Available Found | Available Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| A 15 | Crocker's Potato, Hop and Tobacco | ...... | ...... | 2.08 | **2.08** | *2.06* | $5.82 | 6.21 | 3.60 | 2.19 | **12.00** | *11.* | **9.81** | *10.* | $9.35 | **3.23** | *3.25* | $2.75 | A 15 |
| B 14 | Cumberland Potato Fertilizer | 0.32 | ...... | 1.76 | **2.08** | *2.06* | 5.73 | 5.11 | 3.80 | 3.05 | **11.96** | *11.* | **8.91** | *9.* | 8.87 | **3.53** | *3.* | 3.00 | B 14 |
| A 16 | Cumberland Superphosphate | 0.19 | ...... | 1.76 | **1.95** | *2.06* | 5.40 | 4.95 | 5.16 | 2.50 | **12.61** | *10.* | **10.11** | *8.* | 9.58 | **2.08** | *2.* | 1.77 | A 16 |
| B 12 | Great Eastern General Fertilizer | ...... | ...... | 0.98 | **0.98** | *0.82* | 2.74 | 6.40 | 2.75 | 1.75 | **10.90** | *9.* | **9.15** | *8.* | 8.66 | **4.06** | *4.* | 3.45 | B 12 |
| B 13 | Great Eastern Northern Corn Spec'l | ...... | ...... | 2.88 | **2.88** | *3.* | 8.06 | 6.40 | 2.63 | 1.02 | **10.05** | *9.* | **9.03** | *8.* | 8.27 | **2.14** | *2.* | 1.80 | B 13 |
| A 9 | Lister's Special Potato Fertilizer | ...... | 0.12 | 1.58 | **1.70** | *1.65* | 4.78 | 4.88 | 3.15 | 3.30 | **11.33** | *9.* | **8.03** | *8.* | 8.23 | **3.00** | *3.* | 2.55 | A 9 |
| A 8 | Lister's Success Fertilizer | ...... | 0.15 | 1.23 | **1.38** | *1.24* | 3.89 | 6.24 | 2.93 | 2.95 | **12.12** | *11.5* | **9.17** | *9.5* | 9.14 | **2.12** | *2.* | 1.80 | A 8 |
| ‡B 8 | Lowell Swift's Animal Brand | ...... | 0.25 | 2.49 | **2.74** | *2.47* | 7.72 | 7.26 | 2.00 | 1.10 | **10.36** | *10.* | **9.26** | *9.* | 8.57 | **4.17** | *4.* | 3.78 | B 8 |
| B 6 | Lowell Swift's Bone Fertilizer | ...... | 0.13 | 1.82 | **1.95** | *1.65* | 5.49 | 4.74 | 2.96 | 1.74 | **9.44** | *9.* | **7.70** | *8.* | 7.34 | **3.26** | *3.* | 2.77 | B 6 |
| B 7 | Lowell Swift's D. Bone and Potash | ...... | ...... | 1.90 | **1.90** | *1.65* | 5.32 | 7.59 | 1.48 | 1.42 | **10.49** | *10.* | **9.07** | *9.* | 8.58 | **2.16** | *2.* | 1.84 | B 7 |
| *A 11 | Lowell Swift's Potato Phosphate | ...... | 0.15 | 2.36 | **2.51** | *2.47* | 7.06 | 6.34 | 2.47 | 1.01 | **9.82** | *9.* | **8.81** | *8.* | 8.09 | **6.27** | *6.* | 6.27 | A 11 |
| B 11 | P. G. Co.'s Soluble Pacific Guano | 0.28 | ...... | 1.80 | **2.08** | *2.25* | 5.74 | 5.14 | 4.36 | 2.19 | **11.69** | *10.5* | **9.50** | *8.5* | 8.99 | **2.07** | *2.* | 1.76 | B 11 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

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‡ Potash partly as sulphate

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN: From Nitrates | NITROGEN: From Ammonia Salts | NITROGEN: From Organic Matter | NITROGEN: Total Found | NITROGEN: Total Guaranteed | NITROGEN: Valuation of Nitrogen in One Ton † | PHOSPHORIC ACID: Soluble | PHOSPHORIC ACID: Reverted | PHOSPHORIC ACID: Insoluble | PHOSPHORIC ACID: Total: Found | PHOSPHORIC ACID: Total: Guaranteed | PHOSPHORIC ACID: Available: Found | PHOSPHORIC ACID: Available: Guaranteed | PHOSPHORIC ACID: Valuation of Phosphoric Acid in One Ton † | POTASH: Found | POTASH: Guaranteed | POTASH: Valuation of Potash in One Ton † | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B 5... | Quinnipiac Climax Phosphate......... | ...... | ...... | 1.04 | **1.04** | *1.03* | $ 2.91 | 5.20 | 3.31 | 2.41 | **10.92** | *9.* | **8.51** | *8.* | $8.29 | **2.62** | *2.* | $2.23 | B 5 |
| B 3... | Quinnipiac Corn Manure................ | ...... | ...... | 1.95 | **1.95** | *2.06* | 5.46 | 4.97 | 4.32 | 2.65 | **11.94** | *10.* | **9.29** | *9.* | 8.99 | **1.73** | *1.5* | 1.47 | B 3 |
| B 4... | Quinnipiac Potato Phosphate........... | 0.14 | 0.14 | 1.78 | **2.06** | *2.05* | 5.75 | 4.97 | 3.57 | 3.02 | **11.56** | *9.* | **8.54** | *8.* | 8.54 | **3.19** | *3.* | 2.71 | B 4 |
| B 20.. | Read's Leader Guano.................... | ...... | ...... | 0.98 | **0.98** | *0.83* | 2.74 | 4.58 | 3.05 | 0.86 | **8.49** | *8.* | **7.63** | *7.* | 6.91 | **2.02** | *2.* | 1.72 | B 20 |
| B 18.. | Read's Practical Potato Special....... | ...... | ...... | 1.10 | **1.10** | *0.83* | 3.08 | 2.97 | 2.29 | 0.58 | **5.84** | *5.* | **5.26** | *4.* | 4.73 | **8.06** | *8.* | 6.85 | B 18 |
| B 17.. | Read's Sampson for Potatoes.......... | ...... | ...... | 1.79 | **1.79** | *1.65* | 5.01 | 4.85 | 1.81 | 1.05 | **7.71** | *7.* | **6.66** | *6.* | 6.23 | **4.15** | *4.* | 3.53 | B 17 |
| B 19.. | Read's Standard Superphosphate..... | ...... | ...... | 1.02 | **1.02** | *0.83* | 2.86 | 5.98 | 2.35 | 1.00 | **9.33** | *9.* | **8.33** | *8.* | 7.66 | **4.23** | *4.* | 3.60 | B 19 |
| B 1... | R. C. Co.'s Essex, Corn, Grain, Grass | 0.88 | ...... | 2.58 | **3.46** | *3.7* | 9.42 | 4.54 | 4.67 | 3.22 | **12.43** | *9.5* | **9.21** | *7.* | 9.11 | **10.23** | *9.5* | 8.70 | B 1 |
| *B 2... | R. C. Co.'s Essex, Potatoes and Roots | ...... | 0.71 | 2.83 | **3.54** | *3.7* | 10.05 | 4.63 | 4.96 | 2.94 | **12.53** | *9.* | **9.59** | *7.* | 9.31 | **8.97** | *8.5* | 8.82 | B 2 |
| B 15.. | Tucker's Imperial for Corn............. | ...... | ...... | 1.75 | **1.75** | *1.23* | 4.90 | 5.12 | 3.51 | 2.55 | **11.18** | *11.* | **8.63** | *9.* | 8.44 | **2.60** | *1.85* | 2.21 | B 15 |
| B 9... | W. & C. Co.'s Americus Potato Man. | ...... | 0.16 | 1.97 | **2.13** | *2.06* | 6.00 | 4.72 | 3.58 | 2.70 | **11.00** | *9.* | **8.30** | *8.* | 8.19 | **3.42** | *3.* | 2.91 | B 9 |
| B 10.. | W. & C. Co.'s Royal Bone Phos...... | ...... | ...... | 1.35 | **1.35** | *1.03* | 3.78 | 5.37 | 3.54 | 2.32 | **11.23** | *8.* | **8 91** | *7.* | 8.59 | **2.53** | *2.* | 2.15 | B 10 |

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UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 70

APRIL, 1899

## Analyses of Commercial Fertilizers

I. Statement Regarding Collection of Samples—Pages 55–56.
II. Licensed Fertilizers Sampled by Station—Pages 57–59.
III. Analyses of Licensed Fertilizers—Pages 60–66.
IV. Brands Not Reported in This Bulletin—Page 67–68.

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1899.

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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the East.

# BULLETIN NO. 70.

# ANALYSES OF COMMERCIAL FERTILIZERS.

By J. L. Hills, C. H. Jones and B. O. White.

## I. STATEMENT REGARDING COLLECTION OF SAMPLES.

During March and early April, Messrs. A. R. Nourse of Springfield, A. C. Wells of Bakersfield and O. B. Wood of Georgia, agents of this station, visited seventy-six towns and villages in Vermont and drew two hundred and sixty-three samples, representing one hundred and thirty-seven distinct brands of fertilizer. It is believed that one or more samples of most of the brands of fertilizer sold in the state have been secured this spring. The station desires that farmers, farmers' clubs and granges call its attention to brands of fertilizer on sale not included in this bulletin, either in the tables of analyses or the list of samples on hand. So far as is practicable goods thus reported will be sampled. It should be noted, however, that, as a rule, the station will not sample or analyze :

1. From stock of less than one ton.
2. From stock which has been carried over from a former season.
3. From stock which has been improperly stored.

Bulletin 69 distributed to the state mailing list April 10, contained analyses of composite samples (mixture of equal portions of several samples of the same brand taken from different parts of the state) of leading brands licensed for sale in the state. The present bulletin contains the analyses of samples of 80 distinct brands, the output of 18 manufacturers. The 36 analyses published in Bulletin 69 are reprinted to facilitate ready reference.

The 80 brands reported comprise all those of which (with a few exceptions) two or more samples were found by the station agents. There is reason to believe that over 90 per cent of the trade in the state is confined to these brands.

The reader is referred to Bulletin 69 for details regarding the schedule of trade values and their application to superphosphates and mixed goods. The values per pound of the ingredients as found in mixed goods are as follows: Ammoniacal, nitrate and organic nitrogens, 15, 12½ and 14 cents respectively ; soluble, reverted and insoluble phosphoric acids, 4½, 4 and 2 cents respectively ; potash, as sulphate, 5 cents, as muriate, 4¼ cents. It should be particularly noted, however, that **these trade values do not represent the proper selling prices of mixed goods at the point of consumption**, but are the retail trade values or cash-costs of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in standard unmixed raw materials of good quality, at the seaboard. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have a purely commercial significance.

The reader is also referred to Bulletins 47 and 65 for a full discussion of the principles and practice of fertilization, with suggestions concerning the selection, purchase and use of artificial fertilizers, and especially to the remarks on home mixing. These, as well as other bulletins and reports, will be sent to any address without charge, on application, as long as the supplies last.

## OBSERVANCE OF THE FERTILIZER LAW.

The following manufacturers and companies have paid licenses as required by the fertilizer law and the sale of any and all brands bearing their names is legal. Agents as well as intending purchasers are warned against the handling of mixed goods of companies other than those listed below, since the former render themselves liable to fine, and the latter, in buying the goods of companies trying to evade the law, run great risk of getting inferior material. It should be noted, however that "parties manufacturing, importing or purchasing fertilizers for their own use and not for sale in the state" are not affected by the restrictions of the law.

| License Number | NAME OF COMPANY | ADDRESS |
|---|---|---|
| 1 | Pacific Guano Co | Box 1368, Boston, Mass. |
| 2 | Quinnipiac Co | Box 3404, Boston, Mass. |
| 3 | Bradley Fertilizer Co | 92 State St., Boston, Mass. |
| 4 | Cleveland Dryer Co | Box 3404, Boston, Mass. |
| 5 | Lister's Agricultural Chemical Works | Newark, N. J. |
| 6 | Crocker Fertilizer and Chemical Co | P. O. Drawer 142, Buffalo, N. Y. |
| 7 | Standard Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 8 | Cumberland Bone Phosphate Co. | State St., and Merchant's Row, Boston, Mass. |
| 9 | Bowker Fertilizer Co | 43 Chatham St., Boston, Mass. |
| 10 | E. Frank Coe Co | 133–137 Front St., New York, N. Y. |
| 11 | Williams & Clark Fertilizer Co | 92 State St., Boston, Mass. |
| 12 | Great Eastern Fertilizer Co | Rutland, Vt. |
| 13 | Clark's Cove Fertilizer Co | Farlow Building, State St., Boston, Mass. |
| 14 | Henry F. Tucker Co | Farlow Building, State St., Boston, Mass. |
| 15 | Read Fertilizer Co | Box 3121, New York, N. Y. |
| 16 | Lowell Fertilizer Co | 44 North Market St., Boston, Mass. |
| 17 | H. J. Baker & Bro | 93–97 William St., New York, N. Y. |
| 18 | Russia Cement Co | Gloucester, Mass. |

## II. LICENSED FERTILIZERS SAMPLED BY STATION.

### H. J. Baker & Co., New York, N. Y.

**E2. Harvest Home**: from stocks of Albert Gilson, North Hartland; G. M. Metcalf, Chelsea.

**E16. Standard UNXLD**; from stock of G. M. Metcalf, Chelsea.

### Bowker Fertilizer Co., Boston, Mass.

**C3. Hill and Drill Phosphate**; from stock of G. A. Wales, East Barre.

**C4. Market Garden Fertilizer**; from stock of H. H. Meader, Marshfield.

**D1. Potato and Vegetable Phosphate**; from stock of G. A. Wales, East Barre.

**E3. Stockbridge Manure for Corn**; from stocks of W. C. Bugbee, Bridgewater Corners; H. S. Annis, Chelsea; H. E. Kelley, Bradford.

**E4. Stockbridge Manure for Potatoes**; from stocks of H. E. Kelley, Bradford; A. L. Aseltine, Swanton.

**E5. Sure Crop Phosphate**; from stocks of H. S. Annis, Chelsea; W. C. Bugbee, Bridgewater Corners.

**E6. Vermont Phosphate**; from stocks of H. S. Annis, Chelsea; L. F. Fortney, Plainfield.

### Bradley Fertilizer Co., Boston, Mass.

**C5. Complete Manure with Ten per cent. Potash**; from stock of L. H. Warren, Hardwick.

**D15. English Lawn Dressing**; from stock of A. G. Peirce, Burlington.

**E14. Potato Manure**; from stocks of B. S. Hooker, Bradford; E. B. Arbuckle, East Montpelier.

**D16. XL Superphosphate of Lime**; from stock of A. G. Peirce, Burlington.

### Clark's Cove Fertilizer Co, Boston, Mass.

**E9. Bay State Fertilizer, G. G.**; from stocks of L. D. Spooner, Randolph; G. L. Swan, North Tunbridge; L. O. Brush, Underhill Center.

**E10. King Philip Alkaline Guano**; from stocks of G. L. Swan, North Tunbridge; Knight & Walker, West Brattleboro; J. H. Silsby, Lunenburgh.

**E8. Potato Fertilizer**; from stocks of G. L. Swan, North Tunbridge; J. H. Silsby, Lunenburgh; L. O. Brush, Underhill Center.

### Cleveland Dryer Co., Boston, Mass.

**C10. Corn and Grain Phosphate**; from stock of J. H. Chaffee, Enosburgh Falls.

C11. **Fertilizer for all Crops**; from stock of J. H. Chaffee, Enosburgh Falls.

**E. Frank Coe Co., New York, N. Y.**

C14. **Celebrated Special Grass and Grain Fertilizer**; from stock of R. J. Gates, Franklin.

D4. **Prize Brand for Grass and Grain**; from stock of J. B. Freeman, Glover.

C15. **XXV Ammoniated Bone Superphosphate**; from stock of John Doe, Newbury.

**Crocker Fertilizer and Chemical Co., Buffalo, N. Y.**

E15. **Ammoniated Bone Superphosphate**; from stocks of E. A. Dutton, Craftsbury; L. F. Fortney, Plainfield.

C2. **New Rival Ammoniated Bone Superphosphate**; from stocks of D. M. Smith, East Concord; J. B. Brock, Newbury.

**Cumberland Bone Phosphate Co, Boston, Mass.**

D3. **Corn Fertilizer**; from stock of A. A. Goodell, South Windham.

D2. **Fertilizer for all Crops**; from stock of A. A. Goodell, South Windham.

**Great Eastern Fertilizer Co., Rutland, Vt.**

E13. **Grass and Oats**; from stocks of L. C. Sturtevant, Weybridge: C. P. Dickenson, Chelsea; R. C. Martin, Bradford.

C7. **Potato Manure**; from stock of T. G. Bronson, East Hardwick.

**Lister's Agricultural Chemical Works, Newark, N. J.**

D7. **Animal Bone and Potash**; from stock of John Smith, Hyde Park.

D5. **Lawn Fertilizer**; from stock of T. J. Gagner, St. Johnsbury.

C16. **Oneida Special**; from stock of G. W. Pratt, Newport.

D6. **Special Corn Fertilizer**; from stock of C. L. Hooper, Randolph.

**Pacific Guano Co, Boston, Mass.**

E12. **Nobsque Guano**; from stocks of W. M. Murphy, Brattleboro; L. D. Spooner, Randolph.

C6. **Potato Special**; from stock of W. M. Murphy, Brattleboro.

**Quinnipiac Co, Boston, Mass.**

D8. **Mohawk Fertilizer**; from stock of N. W. Batchelder, Newfane.

E11. **Phosphate**; from stocks of S. C. Ranney, Lyndon.

**Read Fertilizer Co., New York, N. Y.**

C12. **Farmers' Friend Superphosphate**; from stock of E. E. Putnam, South Newbury.

D12. **Fish, Bone and Potash**; from stock of Chas. Kelton, Glover.

D13. **Potato Manure**; from stock of W. S. Newcomb, Hyde Park.

C13. **Vegetable and Vine Fertilizer**; from stock of R. E. Beard, East Barre.

**Russia Cement Co., Gloucester, Mass.**

D10. **Essex Corn Fertilizer**; from stock of A. D. Loop, Hartland.

D11. **XXX Fish and Potash**; from stock of A. D. Loop, Hartland.

**Standard Fertilizer Co., Boston, Mass.**

E7. **Fertilizer**; from stocks of L. H. Lamphier, Morrisville; J. H. Bushnell, Williston; C. W. Atherton, Waterbury.

**H. F. Tucker Co., Boston, Mass.**

C8. **Imperial Bone Superphosphate for all Crops**; from stock of A. C. Larrabee, Berkshire.

C9. **Imperial Bone Superphosphate for Potatoes**; from stock of A. C. Larrabee, Berkshire.

**Williams & Clark Fertilizer Co., Boston, Mass.**

C1. **Americus Corn Phosphate**; from stocks of A. M. Whitcomb, Hyde Park; C. S. Kimball, Northfield; Valley Grain Co., Brattleboro.

E1. **Prolific Crop Producer**; from stocks of P. V. Cook, Leicester Junction; Urie & Sawyer, Craftsbury.

### EXPLANATION OF THE TABLES OF ANALYSES.

The figures in the tables of analyses of licensed fertilizers upon pages 60–66 show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 42 of this bulletin, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicized* type gives *guarantees*, the **black-face** type gives the **most important figures found by analysis.**

## III. ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| E 2... | Baker's Harvest Home Fertilizer..... | 0.32 | ...... | 1.00 | 1.32 | *1.03* | $3.60 | 5.15 | 3.64 | 1.29 | 10.08 | *9.* | 8.79 | *8.* | $8.06 | 2.46 | *2.* | $2.09 | E 2 |
| E 16.. | Baker's Standard UnXLD Fertilizer.. | 0.48 | 0.35 | 1.30 | 2.13 | *1.85* | 5.89 | 7.45 | 1.95 | 0.53 | 9.93 | *9.* | 9.40 | *8.* | 8.48 | 3.05 | *2.25* | 2.59 | E 16 |
| C 3... | Bowker's Hill and Drill Phosphate.. | 0.70 | ...... | 2.02 | 2.72 | *2.47* | 7.41 | 7.59 | 2.99 | 2.21 | 12.79 | *12.* | 10.58 | *9.* | 10.11 | 2.46 | *2.* | 2.09 | C 3 |
| C 4... | Bowker's Market Garden Fertilizer.. | 0.85 | ...... | 1.65 | 2 50 | *2.47* | 6.75 | 5.49 | 2.88 | 2.83 | 11.20 | *8.* | 8.37 | *6.* | 8.38 | 9.97 | *10.* | 8.47 | C 4 |
| A 2... | Bowker's Potash or Staple Phosphate | 0.19 | ...... | 0.64 | 0.83 | *0.82* | 2.27 | 3.71 | 4.04 | 2.67 | 10.42 | *10.* | 7.75 | *8.* | 7.64 | 3.14 | *3.* | 2.67 | A 2 |
| D 1... | Bowker's Potato and Vegetable Phos. | 0.49 | ...... | 1.33 | 1.82 | *1.65* | 4.95 | 5.72 | 3.29 | 2.40 | 11.41 | *11.* | 9.01 | *9.* | 8.74 | 2.10 | *2.* | 1.79 | D 1 |
| E 3... | Bowker's Stockbridge Corn Manure. | 1.33 | ...... | 2.09 | 3.42 | *3.29* | 9.18 | 6.11 | 2.04 | 2.38 | 10.53 | *10.* | 8.15 | *8.* | 8.08 | 7.45 | *7.* | 6.33 | E 3 |
| E 4... | Bowker's Stockbridge Potato Manure | 1.32 | ...... | 2.11 | 3.43 | *3.29* | 9.21 | 4.71 | 1.96 | 2.76 | 9.43 | *8.* | 6.67 | *6.* | 6.91 | 10.22 | *10.* | 8.69 | E 4 |
| E 5... | Bowker's Sure Crop Phosphate........ | 0.19 | ...... | 0.89 | 1.08 | *0.82* | 2.97 | 5.47 | 3.66 | 2.75 | 11.88 | *11.* | 9.13 | *9.* | 8.95 | 2.30 | *2.* | 1.96 | E 5 |
| A 1... | Bowker's Vt. Grange Chem. D Brand | 0.88 | ...... | 1.63 | 2.51 | *2.06* | 6.76 | 4.47 | 3.07 | 2.44 | 9.98 | *9.* | 7.54 | *8.* | 7.43 | 4.01 | *3.* | 3.41 | A 1 |
| E 6... | Bowker's Vermont Phosphate......... | 1.03 | ...... | 1.56 | 2 59 | *2.06* | 6.94 | 4.57 | 2.23 | 2.90 | 9.70 | *10.* | 6.80 | *8.* | 7.06 | 3.87 | *3.* | 3.29 | E 6 |
| C 5... | Bradley's Complete 10% Potash...... | 0.18 | 0.17 | 2.59 | 2.94 | *3.3* | 8.21 | 5.41 | 2.67 | 1.87 | 9.95 | *7.* | 8.08 | *6.* | 7.75 | 10.17 | *10.* | 8.64 | C 5 |

*Potash in brands thus marked is largely if not entirely in the form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†"Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43–46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| A 5... | Bradley's Corn Phosphate........... | ...... | ...... | 2.09 | **2.09** | *2.06* | $ 5.85 | 4.77 | 4.28 | 2.51 | **11.56** | *10.* | **9.05** | *9.* | $8.72 | **1.60** | *1.5* | $1.36 | A 5 |
| A 13.. | Bradley's Eclipse Phosphate........... | 0.17 | ...... | 1.23 | **1.40** | *1.* | 3.87 | 5.14 | 3.94 | 3.27 | **12.35** | *12.* | **9.08** | *10.* | 9.09 | **1.61** | *1.5* | 1.37 | A 13 |
| *D 15.. | Bradley's English Lawn Dressing... | 4.86 | ...... | 0.04 | **4.90** | *4.95* | 12.26 | 1.51 | 4.66 | 1.82 | **7.99** | *6.* | **6.17** | *5.* | 5.82 | **2.79** | *2.5* | 2.75 | D 15 |
| E 14.. | Bradley's Potato Manure............... | 0.84 | ...... | 1.67 | **2.51** | *2.5* | 6.78 | 2.95 | 3.18 | 3.25 | **9.38** | *8.* | **6.13** | *6.* | 6.48 | **5.35** | *5.* | 4.55 | E 14 |
| A 12.. | Bradley's Potato Fertilizer............. | 0.19 | ...... | 1.97 | **2.16** | *2.06* | 6.00 | 4.79 | 3.93 | 2.51 | **11.23** | *11.* | **8.72** | *9.* | 8.46 | **3.51** | *3.25* | 2.98 | A 12 |
| A 4... | Bradley's Vermonter for all Crops... | 0.28 | ...... | 1.92 | **2.20** | *2.06* | 6.08 | 4.84 | 3.87 | 2.06 | **10.77** | *10.* | **8.71** | *8.* | 8.28 | **3.52** | *3.5* | 2.99 | A 4 |
| A 3... | Bradley's XL Superphosphate......... | 0.47 | ...... | 1.97 | **2.44** | *2.5* | 6.69 | 6.58 | 2.61 | 1.90 | **11.09** | *11.* | **9.19** | *9.* | 8.77 | **2.20** | *2.* | 1.87 | A 3 |
| ‡D 16.. | Bradley's XL Superphosphate......... | 0.49 | ...... | 2.01 | **2.50** | *2.5* | 6.86 | 5.36 | 4.52 | 4.10 | **13.98** | *11.* | **9.88** | *9.* | 10.08 | **2.09** | *2.* | 1.77 | D 16 |
| E 9... | Clark's Cove Bay State Fert. G. G... | 0.50 | ...... | 1.87 | **2.37** | *1.85* | 6.49 | 5.78 | 3.50 | 2.59 | **11.87** | *10.* | **9.28** | *8.5* | 9.04 | **2.21** | *2.* | 1.88 | E 9 |
| E 10.. | Clark's Cove King Philip Alk. Gua.. | ...... | ...... | 1.25 | **1.25** | *1.03* | 3.50 | 4.89 | 3.38 | 2.40 | **10.67** | *9.* | **8.27** | *8.* | 8.07 | **2.33** | *2.* | 1.98 | E 10 |
| E 8... | Clark's Cove Potato Fertilizer......... | 0.46 | ...... | 1.70 | **2.16** | *2.06* | 5.91 | 5.88 | 2.99 | 3.00 | **11.87** | *9.* | **8.87** | *8.* | 8.88 | **3.29** | *3.* | 2.80 | E 8 |
| C 10.. | Cleveland Corn and Grain Phos...... | 0.33 | ...... | 1.74 | **2.07** | *2.06* | 5.70 | 3.89 | 4.22 | 4.20 | **12.31** | *10.5* | **8.11** | *9.5* | 8.56 | **1.62** | *1.5* | 1.38 | C 10 |

*Potash in brands thus marked is largely if not entirely in the form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

‡Analyzed at request of manufacturers, who did not consider that A 3 represented their goods.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| C 11.. | Cleveland Fertilizer for all Crops..... | ...... | ...... | 1.11 | **1.11** | *1.03* | $ 3 11 | 3.99 | 3.71 | 2.78 | **10.48** | *9.* | **7.70** | *8.* | $ 7.67 | **2.31** | *2.* | $1.96 | C 11 |
| A 10.. | Cleveland Potato Phosphate............ | 0.23 | ...... | 1.76 | **1.99** | *2.06* | 5.51 | 5.15 | 3.83 | 3.42 | **12.40** | *10.* | **8.98** | *8.* | 9.06 | **3.01** | *3.* | 2.56 | A 10 |
| C 14.. | Coe's Cel. Spec. Grass and Grain...... | ...... | ...... | 0.86 | **0.86** | *0.83* | 2.41 | 5.60 | 3.59 | 2.68 | **11.87** | *10.5* | **9.19** | *8.5* | 8.98 | **1.79** | *1.5* | 1.52 | C 14 |
| *A 7... | Coe's Columbian Corn Fertilizer...... | ...... | 0.13 | 1.14 | **1.27** | *1.2* | 3.58 | 5.90 | 3.53 | 2.39 | **11.82** | *10.5* | **9.43** | *8.5* | 9.09 | **2.66** | *2.5* | 2.66 | A 7 |
| *A 6... | Coe's Columbian Potato Fertilizer... | ...... | 0.12 | 1.13 | **1.25** | *1.2* | 3.52 | 6.39 | 3.08 | 1.99 | **11.46** | *10.5* | **9.47** | *8.5* | 9.02 | **2.53** | *2.5* | 2.53 | A 6 |
| B 16.. | Coe's N. E. Special for Potatoes....... | ...... | ...... | 0.84 | **0.84** | *0.8* | 2.35 | 6.03 | 2.88 | 1.55 | **10.46** | *8.5* | **8.91** | *7.* | 8.36 | **3 23** | *3.* | 2.75 | B 16 |
| D 4... | Coe's Prize Brand Grass and Grain... | ...... | ...... | ...... | ...... | ...... | ......... | 6.32 | 4.10 | 2.17 | **12.59** | *12.* | **10.42** | *10.5* | 9.84 | **2.36** | *2.* | 2.01 | D 4 |
| C 15.. | Coe's XXV Ammo. Bone Superphos | ...... | ...... | 1.00 | **1.00** | *0.80* | 2.80 | 6.36 | 3.45 | 1.90 | **11.71** | *9.* | **9.81** | *8.* | 9.23 | **1 83** | *1.5* | 1.56 | C 15 |
| E 15.. | Crocker's Ammo. Bone Superphos... | ...... | ...... | 2.32 | **2 32** | *2.9* | 6.50 | 8.03 | 2.71 | 1.25 | **11.99** | *11.* | **10.74** | *10.* | 9.90 | **2.38** | *1.08* | 2.02 | E 15 |
| A 14.. | Crocker's Ammo. Corn Phosphate... | ...... | ...... | 2.03 | **2.03** | *2.* | 5.68 | 6.43 | 3.18 | 2.42 | **12.03** | *11.* | **9.61** | *10.* | 9.30 | **1.71** | *1.6* | 1.45 | A 14 |
| C 2... | Crocker's New Rival Ammo. Bone... | ...... | ...... | 1.39 | **1.39** | *1.23* | 3.89 | 6.01 | 3.74 | 2.06 | **11.81** | *11.* | **9.75** | *10.* | 9.23 | **1.65** | *1.6* | 1.40 | C 2 |
| A 15.. | Crocker's Potato, Hop and Tobacco.. | ...... | ..... | 2.08 | **2.08** | *2.06* | 5.82 | 6.21 | 3.60 | 2.19 | **12.00** | *11.* | **9.81** | *10.* | 9.35 | **3.23** | *3.25* | 2.75 | A 15 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton † | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton† | |
| D 3... | Cumberland Corn Fertilizer............ | 0.42 | ...... | 1.54 | **1.96** | *1.65* | $ 5.36 | 4.81 | 3.89 | 3.17 | **11.87** | *9.* | **8.70** | *8.* | $8.71 | **2.15** | *2.* | $1.83 | D 3 |
| D 2... | Cumberland Fertilizer for all Crops.. | ...... | ...... | 1.25 | **1.25** | *1.03* | 3.50 | 4.95 | 3.37 | 2.60 | **10.92** | *10.* | **8.32** | *8.* | 8.19 | **2.11** | *2.* | 1.79 | D 2 |
| B 14.. | Cumberland Potato Fertilizer .... .... | 0.32 | ...... | 1.76 | **2.08** | *2.06* | 5.73 | 5.11 | 3.80 | 3.05 | **11.96** | *11.* | **8.91** | *9.* | 8.87 | **3.53** | *3.* | 3.00 | B 14 |
| A 16.. | Cumberland Superphosphate........... | 0.19 | ...... | 1.76 | **1.95** | *2.06* | 5.40 | 4.95 | 5.16 | 2.50 | **12.61** | *10.* | **10.11** | *8.* | 9.58 | **2.08** | *2.* | 1.77 | A 16 |
| B 12.. | Great Eastern General Fertilizer...... | ...... | ...... | 0.98 | **0.98** | *0.82* | 2.74 | 6.40 | 2.75 | 1.75 | **10.90** | *9.* | **9.15** | *8.* | 8.66 | **4.08** | *4.* | 3.45 | B 12 |
| E 13.. | Great Eastern Grass and Oats Fert... | ...... | ...... | ...... | ...... | ...... | ......... | 4.96 | 6.42 | 1.57 | **12.95** | *12.* | **11.38** | *11.* | 10.23 | **1.85** | *2.* | 1.58 | E 13 |
| B 13.. | Great Eastern Northern Corn Spec'l | ...... | ...... | 2.88 | **2.88** | *3.* | 8.06 | 6.40 | 2.63 | 1.02 | **10.05** | *9.* | **9.03** | *8.* | 8.27 | **2.14** | *2.* | 1.80 | B 13 |
| C 7... | Great Eastern Potato Manure.......... | ...... | ...... | 2.10 | **2.10** | *2.06* | 5.88 | 6.44 | 2.24 | 0.97 | **9.65** | *9.* | **8.68** | *8.* | 7.98 | **4.05** | *4.* | 3.44 | C 7 |
| D 7... | Lister's Animal Bone and Potash..... | ...... | ...... | ...... | ...... | ...... | ......... | 4.78 | 4.91 | 1.28 | **10.97** | *10.* | **9.69** | *9.* | 8.74 | **5.21** | *5.* | 4.43 | D 7 |
| *D 5... | Lister's Lawn Fertilizer................. | ...... | 1.44 | 0.54 | **1.98** | *1.65* | 5.83 | 5.26 | 2.61 | 0.42 | **8.29** | *8.* | **7.87** | *7.* | 6.99 | **3.89** | *3.5* | 3.89 | D 5 |
| *C 16.. | Lister's Oneida Special.................. | ...... | ...... | 0.79 | **0.79** | *0.62* | 2.21 | 7.37 | 3.06 | 1.95 | **12.38** | *11.* | **10.43** | *10.* | 9.86 | **1.22** | *1.* | 1.22 | C 16 |
| D 6... | Lister's Special Corn Fertilizer....... | ...... | 0.18 | 1.45 | **1.63** | *1.65* | 4.60 | 4.75 | 3.69 | 3.28 | **11.72** | *9.* | **8.44** | *8.* | 8.54 | **3.26** | *3.* | 2.77 | D 6 |

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*** Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.**

**† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.**

**‡ Potash partly as sulphate**

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| A 9.... | Lister's Special Potato Fertilizer...... | ...... | 0.12 | 1.58 | **1.70** | *1.65* | $ 4.78 | 4.88 | 3.15 | 3.30 | **11.33** | *9.* | **8.03** | *8.* | $ 8.23 | **3.00** | *3.* | $2.55 | A 9 |
| A 8... | Lister's Success Fertilizer.............. | ...... | 0.15 | 1.23 | **1.38** | *1.24* | 3.89 | 6.24 | 2.93 | 2.95 | **12.12** | *11.5* | **9.17** | *9.5* | 9.14 | **2.12** | *2.* | 1.80 | A 8 |
| ‡B 8.... | Lowell Swift's Animal Brand.......... | ...... | 0.25 | 2.49 | **2.74** | *2.47* | 7.72 | 7.26 | 2.00 | 1.10 | **10.36** | *10.* | **9.26** | *9.* | 8.57 | **4.17** | *4.* | 3.78 | B 8 |
| B 6... | Lowell Swift's Bone Fertilizer.......... | ...... | 0.13 | 1.82 | **1.95** | *1.65* | 5.49 | 4.74 | 2.96 | 1.74 | **9.44** | *9.* | **7.70** | *8.* | 7.34 | **3.26** | *3.* | 2.77 | B 6 |
| B 7... | Lowell Swift's D. Bone and Potash.. | ...... | ...... | 1.90 | **1.90** | *1.65* | 5.32 | 7.59 | 1.48 | 1.42 | **10.49** | *10.* | **9.07** | *9.* | 8.58 | **2.16** | *2.* | 1.84 | B 7 |
| *A 11 | Lowell Swift's Potato Phosphate...... | ...... | 0.15 | 2.36 | **2 51** | *2.47* | 7.06 | 6.34 | 2.47 | 1.01 | **9.82** | *9.* | **8.81** | *8.* | 8.09 | **6.27** | *6.* | 6.27 | A 11 |
| E 12.. | P. G. Co.'s Nobsque Guano............ | ...... | ...... | 0.70 | **0.70** | *1.15* | 1.96 | 5.18 | 3.58 | 2.25 | **11 01** | *9.* | **8.76** | *8.* | 8.43 | **2.06** | *2.* | 1.75 | E 12 |
| B 11.. | P. G. Co.'s Soluble Pacific Guano..... | 0.28 | ...... | 1.80 | **2.08** | *2.25* | 5.74 | 5.14 | 4.36 | 2.19 | **11.69** | *10.5* | **9.50** | *8.5* | 8.99 | **2.07** | *2.* | 1.76 | B 11 |
| C 6... | P. G. Co.'s Potato Special.............. | ...... | 0.17 | 2.21 | **2.38** | *2.06* | 6.70 | 4.33 | 3.69 | 2.95 | **10.97** | *9.* | **8.02** | *8.* | 8.03 | **3.96** | *3.* | 3.37 | C 6 |
| B 5... | Quinnipiac Climax Phosphate......... | ...... | ...... | 1.04 | **1.04** | *1.03* | 2.91 | 5.20 | 3.31 | 2.41 | **10.92** | *9.* | **8.51** | *8.* | 8.29 | **2.62** | *2.* | 2.23 | B 5 |
| B 3... | Quinnipiac Corn Manure................ | ...... | ...... | 1.95 | **1.95** | *2.06* | 5.46 | 4.97 | 4.32 | 2.65 | **11.94** | *10.* | **9.29** | *9.* | 8.99 | **1 73** | *1.5* | 1.47 | B 3 |
| D 8... | Quinnipiac Mohawk Fertilizer......... | ...... | ...... | 0.84 | **0 84** | *0.82* | 2.35 | 3.62 | 4.14 | 3.59 | **11.35** | *8.* | **7.76** | *7.* | 8.00 | **1.87** | *1.* | 1.59 | D 8 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

‡ Potash partly as sulphate.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| E 11.. | Quinnipiac Phosphate | 0.59 | ...... | 1.97 | **2.56** | *2.47* | $6.99 | 6.65 | 2.65 | 2.06 | **11.36** | *10.* | **9.30** | *9.* | $ 8.93 | **2.26** | *2.* | $1.92 | E 11 |
| B 4... | Quinnipiac Potato Phosphate | 0.14 | 0.14 | 1.78 | **2.06** | *2.05* | 5.75 | 4.97 | 3.57 | 3.02 | **11.56** | *9.* | **8.54** | *8.* | 8.54 | **3.19** | *3.* | 2.71 | B 4 |
| C 12.. | Read's Farmers' Friend Superphos | ...... | ...... | 2.04 | **2.04** | *2.06* | 5.71 | 6.29 | 3.78 | 1.18 | **11.25** | *11.* | **10.07** | *9.* | 9.16 | **2.02** | *2.* | 1.72 | C 12 |
| D 12.. | Read's Fish, Bone and Potash | ...... | ...... | 2.74 | **2.74** | *2.5* | 7.67 | 3.51 | 1.86 | 0.75 | **6.12** | *5.* | **5.37** | *4.* | 4.95 | **4.22** | *4.* | 3.59 | D 12 |
| B 20.. | Read's Leader Guano | ...... | ...... | 0.98 | **0.98** | *0.83* | 2.74 | 4.58 | 3.05 | 0.86 | **8.49** | *8.* | **7.63** | *7.* | 6.91 | **2.02** | *2.* | 1.72 | B 20 |
| D 13.. | Read's Potato Manure | ...... | ...... | 2.56 | **2.56** | *2.5* | 7.17 | 5.36 | 1.82 | 1.19 | **8.37** | *8.* | **7.18** | *7.* | 6.76 | **10.00** | *10.* | 8.50 | D 13 |
| B 18.. | Read's Practical Potato Special | ...... | ...... | 1.10 | **1.10** | *0.83* | 3.08 | 2.97 | 2.29 | 0.58 | **5.84** | *5.* | **5.26** | *4.* | 4.73 | **8.06** | *8.* | 6.85 | B 18 |
| B 17.. | Read's Sampson for Potatoes | ...... | ...... | 1.79 | **1.79** | *1.65* | 5.01 | 4.85 | 1.81 | 1.05 | **7.71** | *7.* | **6.66** | *6.* | 6.23 | **4.15** | *4.* | 3.53 | B 17 |
| B 19.. | Read's Standard Superphosphate | ...... | ...... | 1.02 | **1.02** | *0.83* | 2.86 | 5.98 | 2.35 | 1.00 | **9.33** | *9.* | **8.33** | *8.* | 7.66 | **4.23** | *4.* | 3.60 | B 19 |
| D 10.. | R. C. Co.'s Essex Corn Fertilizer | 0.46 | ...... | 2.00 | **2.46** | *2.* | 6.75 | 2.41 | 6.58 | 4.76 | **13.75** | *11.* | **8.99** | *9.* | 9.34 | **3.60** | *3.* | 3.06 | D 10 |
| B 1... | R. C. Co.'s Essex, Corn, Grain, Grass | 0.88 | ...... | 2.58 | **3.46** | *3.7* | 9.42 | 4.54 | 4.67 | 3.22 | **12.43** | *9.5* | **9.21** | *7.* | 9.11 | **10.23** | *9.5* | 8.70 | B 1 |
| *B 2... | R. C. Co.'s Essex, Potatoes and Roots | ...... | 0.71 | 2.83 | **3.54** | *3.7* | 10.05 | 4.63 | 4.96 | 2.94 | **12.53** | *9.* | **9.59** | *7.* | 9.31 | **8.97** | *8.5* | 8.82 | B 2 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| D 11.. | R. C. Co.'s Essex XXX Fish and Pot | ...... | ...... | 2.25 | **2.25** | *2.1* | $ 6.30 | 5.22 | 4.30 | 4.92 | **14.44** | *12.* | **9.52** | *9.* | $10.11 | **2.61** | *2.25* | $2.22 | D 11 |
| E 7... | Standard Fertilizer...................... | 0.39 | ...... | 1.77 | **2.16** | *2.06* | 5.93 | 4.45 | 3.92 | 3.25 | **11.62** | *10.* | **8.37** | *8.* | 8.44 | **2.18** | *2.* | 1.85 | E 7 |
| C 8... | Tucker's Imperial for all Crops....... | ...... | ...... | 1.96 | **1.96** | *1.23* | 5.49 | 4.95 | 4.81 | 2.08 | **11.84** | *11.* | **9.76** | *9.* | 9.14 | **2.32** | *1.85* | 1.97 | C 8 |
| B 15.. | Tucker's Imperial for Corn............. | ...... | ...... | 1.75 | **1.75** | *1.23* | 4.90 | 5.12 | 3.51 | 2.55 | **11.18** | *11.* | **8.63** | *9.* | 8.44 | **2.60** | *1.85* | 2.21 | B 15 |
| C 9... | Tucker's Imperial for Potatoes......... | ...... | ...... | 1.80 | **1.80** | *1.23* | 5.04 | 4.63 | 4.08 | 2.32 | **11.03** | *11.* | **8.71** | *9.* | 8.36 | **2.47** | *1.85* | 2.10 | C 9 |
| C 1... | W. & C. Co.'s Americus Corn Phos.. | 0.25 | ...... | 2.03 | **2.28** | *2.06* | 6.31 | 4.15 | 4.09 | 3.11 | **11.35** | *10.* | **8.24** | *9.* | 8.25 | **1.68** | *1.5* | 1.43 | C 1 |
| B 9... | W. & C. Co.'s Americus Potato Man | ...... | 0.16 | 1.97 | **2.13** | *2.06* | 6.00 | 4.72 | 3.58 | 2.70 | **11.00** | *9.* | **8.30** | *8.* | 8.19 | **3.42** | *3.* | 2.91 | B 9 |
| E 1... | W. & C. Co.'s Prolific Crop Producer | ...... | ...... | 1.05 | **1.05** | *0.82* | 2.94 | 3.37 | 4.06 | 3.07 | **10.50** | *7.* | **7.43** | *6.* | 7.51 | **1.18** | *1.* | 1.00 | E 1 |
| B 10.. | W. & C. Co.'s Royal Bone Phos....... | ...... | ...... | 1.35 | **1.35** | *1.03* | 3.78 | 5.37 | 3.54 | 2.32 | **11.23** | *8.* | **8.91** | *7.* | 8.59 | **2.53** | *2.* | 2.15 | B 10 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## IV. BRANDS NOT REPORTED IN THIS BULLETIN.

Samples of the following brands are in the laboratory and their analyses will be published on completion in Bulletin 71 about June 1. In but few cases has more than one sample of each of these brands been found by the station agents.

### H. J. BAKER & BRO., New York, N. Y.

Complete Manure for General Use.
Complete Potato Manure.
Complete Potato and Vegetable Manure.
Complete Turnip Manure.
Corn Manure.
Strawberry Manure.

### BOWKER FERTILIZER CO., Boston, Mass.

Corn Phosphate.
Farm and Garden Phosphate.
Potash Bone.
Square Brand Bone and Potash.
Stockbridge Manure for Corn, Grain and Fodder Corn.
Stockbridge Manure for Onions.
Stockbridge Manure for Strawberries.
Stockbridge Manure for Top Dressing.
Superphosphate with Potash.
Ten Per Cent Manure.
Vermont Grange Chemicals, A Brand.

### BRADLEY FERTILIZER CO., Boston, Mass.

Complete Manure for Potatoes and Vegetables.
Niagara Phosphate.
Patent Superphosphate.
Strawberry Manure.

### CLARK'S COVE FERTILIZER CO., Boston, Mass.

Bay State Complete Fertilizer with ten per cent potash.
Triumph Bone and Potash.

### CLEVELAND DRYER CO., Boston, Mass.

High Grade Complete Manure.
Pioneer Fertilizer.
Superphosphate.
Wheat, Rye and Oats Special.

### E. FRANK COE CO., New York, N. Y.

Columbian Ammoniated Bone Superphosphate.
Gold Brand Excelsior Guano.

High Grade Ammoniated Bone Superphosphate.
New England Special for Corn.
Red Brand Excelsior Guano.

CROCKER FERTILIZER AND CHEMICAL CO., Buffalo, N. Y.

Special Potato Manure.
Superior Fertilizer.

CUMBERLAND BONE PHOSPHATE CO., Boston, Mass.

Grass Fertilizer.
Seeding Down Manure.

LISTER'S AGRICULTURAL CHEMICAL WORKS, Newark, N. J.

Potato Manure No. 2.

PACIFIC GUANO CO., Boston, Mass.

Soluble Pacific Guano with ten per cent Potash.

QUINNIPIAC CO., Boston, Mass.

Grass Fertilizer.
Market Garden Manure.
Onion Manure.
Potato Manure.
Seeding Down Manure.
Special Manure with ten per cent Potash.

REED FERTILIZER CO., New York, N. Y.

Bone and Potash Fertilizer.
Corn, Wheat and Rye Fertilizer.
High Grade Farmers' Friend Superphosphate.
New York State Superphosphate.
Sure Catch Fertilizer.
Vegetable and Vine Fertilizer.

STANDARD FERTILIZER CO., Boston, Mass.

Guano for all Crops.
Special for Potatoes.

HENRY F. TUCKER CO., Boston, Mass.

Original Bay State Bone Superphosphate.
Special Potato Fertilizer.

WILLIAMS & CLARK FERTILIZER CO., Boston, Mass.

Americus Ammoniated Bone Superphosphate.
Americus Potato Manure.
High Grade Special for Potatoes, Onions, Tobacco, Cabbage and Cauliflower.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 71

MAY, 1899

# Analyses of Commercial Fertilizers

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VI. ANALYSES FOR FIVE YEARS—Pages 103-113.
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☞Copies of the reports and bulletins of the Station are sent free of charge to any address upon application.

☞Address all communications, not to individual officers, but to the Agricultural Experiment Station, Burlington, Vt.

Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

Experiment Farm and buildings are on the Williston road, adjoining the University grounds on the East.

# BULLETIN NO 71.

By J. L. Hills, C. H. Jones and B. O. White.

## I. SUMMARY.

II. **The station has analyzed 137 brands, the output of eighteen companies, all drawn from dealers' stocks, all this year's goods.**

*1. Quantity of plant food furnished.* **Three-fourths of the brands were up to or above guaranty, one-fourth fell short somewhat, while one-tenth failed to furnish a commercial equivalent of their guaranties. A few cases of deficiency were serious. The percentage of failure to meet claims is greater than has been found of late years. (Pages 73–76.)**

*2. Quality of plant food furnished.* **While as a rule the quality of the crude stock used was good, there were some cases which seem open to criticism. Two-fifths of the brands carried no water-soluble nitrogen. Laboratory methods seem to indicate that somewhat inferior forms of nitrogen were used in certain cases, notably in some low grade goods and by some companies. The phosphoric acid was in some cases quite largely in the insoluble or reverted forms, indicating apparently either imperfect manufacture, old goods, or more or less use of (agriculturally) inferior forms of this ingredient. Sulphate of potash is claimed to be present in nine-tenths of the brands, but was actually found in less than one eighth of the entire number. (Pages 76–79.)**

*3. Selling prices and valuations.* **The average selling price approximated $28.75 and the average valuation, $17.39. Two dollars in every five paid for fertilizers met costs of manufacture and sale. The same amount of plant food which cost a dollar might have been bought at retail for cash at the seaboard for 56 cents in average low priced goods, for 61 cents in average medium grade brands, and for 66 cents in average high priced goods. In one-third of the entire number of brands, a dollar was charged for amounts of plant food which might have been bought in the manner above stated for 55 cents or less. "Cheap fertilizers" are usually the most expensive to buy. (Pages 79–85.)**

V. *The average composition* **of the brands sold is slightly lower than last year. Selling prices have dropped, and plant food is as cheap as it ever was. Notwithstanding these facts, buying mixed goods on time is still a far more costly method of getting plant food than is home-mixing or buying on special order. (Pages 101–102.)**

VI. *The comparison of analyses of 133 brands for five years* **shows in some essential evenness and in others considerable variation in composition. The tables showing composition for five years should prove helpful to the early buyer of mixed goods. (Pages 103–113.)**

## II. RESULTS OF INSPECTION

### COLLECTION OF SAMPLES

The sampling agents of the station visited 77 towns and villages in Vermont during the spring of 1899 and drew 256 samples from dealers' stocks, representing 137 distinct brands, the output of 18 companies licensed to sell in Vermont. It is thought that every brand sold in the state this spring has been sampled and analyzed, although possibly in a few cases small lots of special brands may not have been sampled.

Several samples of crude stock were drawn by the sampling agents and some have been sent to the station for analysis during the course of the year. The analyses of these materials appear on pages 114–116 of the present bulletin. The samples of mixed goods and of crude stock, analyzed number 185 and are classified in the following table. Some 40 or more samples of home-mixed fertilizers, ashes, muck and the like have been made and will be published in the next report. The pages of this bulletin upon which analyses of each class of fertilizer and the discussion thereof appear are indicated in parentheses.

| | | |
|---|---|---|
| Total commercial mixed brands | 140 | ( pages 89–100) |
| Nitrate of soda | 8 | ( " 114 ) |
| Cottonseed meals | 7 | ( " 114 ) |
| Dried blood | 5 | ( " 114 ) |
| Bone meals, tankage, fish scrap, etc | 6 | ( " 115 ) |
| Acid phosphate, etc | 8 | ( " 116 ) |
| Potash salts | 11 | ( " 116 ) |
| | 185 | |

### SCHEDULE OF TRADE VALUES

The schedule of trade values to be used in this state in 1899, was published in Bulletin 69, to which the reader is referred for details as to figures, nature and proper functions.

In applying trade values to mixed goods, organic nitrogen is valued at 14 cents a pound; nitrogen in nitrate of soda and in sulphate of ammonia at 12½ and 15 cents a pound respectively; soluble, reverted and insoluble phosphoric acids at 4½, 4 and 2 cents a pound respectively; potash at 4¼ cents a pound, if there is sufficient chlorin to unite with all the potash, if not it is valued at 5 cents.

The "station valuation" is obtained by *multiplying the given per cent of each constituent* (*nitrogen, soluble, reverted and insoluble phosphoric acids and potash*) *by its trade value, adding the products and multiplying the sum by 20.*

### BULLETINS 69, 70 AND 71

Bulletin 69, distributed to the state mailing list April 5, contained 36 analyses; Bulletin 70, a reprint of these together with 44 more; and the present bulletin, a reprint together with 57 more, thus covering the business of the year. Brands apparently in most common use were reported in the earlier issues. The state law requires monthly issue during the season.

### 1. GUARANTIES AND ANALYSES.

*Over three-fourths* (105 in 137) of the brands analyzed were found to be up to or above guaranty* in nitrogen, available phosphoric acid and potash. Nearly a quarter of the brands (32) showed a shortage of over 0.20 per cent in some one ingredient, and three brands were thus deficient in two ingredients. Fourteen brands were short more than half a per cent and there were several serious deficiencies. Indeed the result of this year's inspection is the most unsatisfactory for some time, there being a larger percentage of failures to meet guaranties than has been found during the past five years. (See table below.) In 22 cases the deficiency appears due to imperfect mixing or to mechanical separation after mixing, and a sufficient excess of other plant food was found present to furnish a money equivalent of the guaranty. In 13 cases, however, the commercial equivalent of the manufacturer's promise was not found in the goods as sold. In as many cases as practicable where serious deficiency was found, re-sampling and re-analysis was resorted to in order to verify results.

Fortunately the brands which fall much below the claims made for them seem to have relatively small sale in this state. The most serious case is that of a so-called "special potato" fertilizer which for three years has been found to be decidedly short of guaranty in available phosphoric acid and potash, although slightly above guaranty in nitrogen. (See tables, pages 105–113.)

*It may be said in brief that three-fourths of the brands sold contained the plant food which was claimed for them, that nine-tenths of them offered the commercial equivalent of their guaranties, but that a tenth of the brands fell short of furnishing the money value or the plant food which they were said to contain.*

The condensed results of five years' inspections so far as they relate to maintenance of guaranty follow:

| Year | Number of brands analyzed | Number of brands above guaranty throughout | Number of brands seriously deficient | Per cent of total number essentially up to guaranty | Per cent of total number affording commercial equivalent of guaranty |
|---|---|---|---|---|---|
| 1895 | 92 | 60 | 16 | 83 | 95 |
| 1896 | 110 | 70 | 19 | 83 | 99 |
| 1897 | 134 | 86 | 21 | 84 | 94 |
| 1898 | 126 | 98 | 13 | 90 | 100 |
| 1899 | 137 | 105 | 32 | 77 | 90 |

The 32 deficiencies of 0.20 per cent or more were distributed among the ingredients as follows: nitrogen 7, available phosphoric acid 23, potash 4.

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*Within 0.20 per cent of guaranty is considered "up to guaranty."

The following table shows the number of brands sold by the different companies licensed in the state, the number of guaranties (nitrogen, available phosphoric acid, potash) made by each, and the number of failures to make the same good (within 0.20 per cent) as judged by the analyses of the samples taken by the station :

MAINTENANANCE OF GUARANTIES BY LICENSEES

| Name of company | Number of brands | Number of guarantees | Number of guarantees not made good |
|---|---|---|---|
| H. J. Baker & Bro... .................. | 7 | 21 | 1 |
| Bowker Fertilizer Co.................. | 20 | 59 | 6 |
| Bradley Fertilizer Co........... ...... | 13 | 39 | 4 |
| Clark's Cove Fertilizer Co........... | 5 | 14 | 0 |
| Cleveland Dryer Co.................... | 7 | 21 | 4 |
| E. Frank Coe Co........................ | 11 | 32 | 2 |
| Crocker Fert. and Chem. Co........ | 6 | 18 | 7 |
| Cumberland Bone Phosphate Co.. | 6 | 18 | 0 |
| Great Eastern Fertilizer Co......... | 4 | 11 | 0 |
| Lister's Agr. Chem. Works......... | 7 | 20 | 1 |
| Lowell Fertilizer Co......... ......... | 4 | 12 | 1 |
| Pacific Guano Co........... ............ | 4 | 12 | 1 |
| Quinnipiac Co........................... | 11 | 33 | 1 |
| Read Fertilizer Co...................... | 13 | 37 | 2 |
| Russia Cement Co...................... | 4 | 12 | 1 |
| Standard Fertilizer Co............... | 3 | 9 | 0 |
| Henry F. Tucker Co..................... | 5 | 15 | 4 |
| Williams & Clark Fert. Co......... | 7 | 21 | 1 |
| Total................. ................ | 137 | 404 | 36 |

The range of composition and the closeness with which guaranties are met are shown in the following table :

LOWEST, HIGHEST AND AVERAGE GUARANTIES, ANALYSES, SELLING PRICES AND VALUATIONS

| | Per cent guaranteed | | | Per cent found | | | Excess of average analysis over guaranty |
|---|---|---|---|---|---|---|---|
| | Lowest | Highest | Average | Lowest | Highest | Average | |
| Nitrogen .............. | 0.62 | 5.75 | 1.98 | 0.70 | 5.99 | 2.06 | 0.08 |
| Total Phos. Acid .. | 5. | 12. | 9.30 | 5.63 | 14.10 | 10.66 | 1.36 |
| Avail. Phos. Acid.. | 4. | 11. | 7.83 | 5.08 | 11.55 | 8.40 | 0.57 |
| Potash ......... ...... | 1. | 10. | 3.37 | 1.18 | 10.80 | 4.10 | 0.73 |
| Selling price......... | $22.00 | $43.00 | $28.80 | | | | |
| Valuation ............ | $ 8.85 | $28.55 | $16.27 | $10.15 | $29.30 | $17.39 | |

For several years manufacturers have given as a rule but little more plant food than is shown by their minimum guaranty, which is exceeded on the average by but 10 per cent. Maximum guaranties are meaningless and misleading.

While this table shows, among other things, that on the average the quality of the fertilizers sold was as good as it was promised to be, a careful scrutiny of the tables on pages 89–100 show that covered by this average lie concealed several deficiencies. This point has already been referred to on page 73. Ninety per cent of the brands contain as much money value as is guaranteed, but in only 77 per cent is it proportioned according to claims. Twenty-three per cent of the goods are out of balance with claims and 10 per cent are positively short of the promises made for them. These statements are repeated here that the facts may not be lost sight of in the comfortable assurance that the fertilizers of the state average well.

### GUARANTIES AND BRAND NAMES

Guaranties are often designedly confusing and convey wrong impressions. Nitrogen, phosphoric acid and potash are what make fertilizers agriculturally and commercially valuable. They are often expressed, however, in guaranties as ammonia, bone phosphate of lime and sulphate of potash. This is done to make a semblance of giving large percentages of plant food. Thus "nitrogen equivalent to ammonia," 2.50 per cent really guarantees only 2.06 per cent nitrogen; "available phosphoric acid equivalent to bone phosphate of lime," 21.80 per cent promises but 10 per cent available; and potash (sulphate), 3.70 per cent, but 2 per cent potash.

Buyers should remember these facts and ignore in the guaranty everything except the lower figures for nitrogen (not ammonia or nitrogen equivalent to ammonia), available phosphoric acid and potash (not sulphate of potash, or potash sulphate, or potash equivalent to or equal to sulphate). In cases where ammonia (or nitrogen equivalent to ammonia) or sulphate of potash or bone phosphate only are shown, their nitrogen, potash and phosphoric acid equivalents may be obtained by multiplying their respective guaranties by 0.823, 0.54 and by 0.459.

Sometimes where both nitrogen and ammonia or both potash and sulphate of potash are stated, the minimum figures of each are discordant. Thus for example nitrogen, 3 per cent, ammonia, 4 per cent, is guaranteed in one brand, yet 4 per cent of ammonia is equivalent to 3.29 per cent nitrogen. In another brand 2.5 per cent potash, and 5 per cent sulphate of potash are guaranteed, yet the latter figure is equivalent to 2.7 per cent potash. Many similar cases might be cited. The buyer would be on the safe side in assuming the lower figure as the true guaranty.

Brand names may or may not bear relation to the usefulness of the goods. Far too frequently the words "bone," "guano," "dissolved bone,"

" high grade " have no significance; usually the more high-flown the name, the lower grade the goods; and it often happens that so-called special fertilizers but poorly suit the nature of the crops whose names they bear. Indeed the variations in formulas and guaranties of goods intended for the same crop show that manufacturers disagree as to crop requirements. The very firms which strenuously assert the importance of special fertilizers shovel several from the same bin, selling the self-same goods as corn fertilizer, as potato manure and as good for all kinds of crops. This condition of affairs affords one of the many valid reasons for the law which requires a guaranty of composition and conformity therewith.

## 2. SOURCES FROM WHICH PLANT FOOD IS DERIVED.

The table on page 74, as well as those on pages 89-100, show wide ranges in composition, amounts of nitrogen varying from 0.70 to 5.99 per cent, of available phosphoric acid from 5.08 to 11.55 per cent and of potash from 1.18 to 10.80 per cent. These figures alone, however, do not tell the whole story as to the character of the ingredients used, a matter of quite as much importance as their amounts. More complete analyses and the further scrutiny of the results throw some light on the sources whence the plant foods were derived.

*Nitrogen.* Fifteen of the eighteen manufacturers selling in this state this year used more or less water-soluble nitrogen (as nitrate of soda, sulphate of ammonia or both) in one or more of their brands. Ten of them used it in most or all of the brands and 8 have habitually done so for years. In 60 per cent of the brands analysed more or less water-soluble nitrogen was present in amounts varying from 0.12 to 4.86 per cent and averaging 0.75 per cent (30 per cent of the total nitrogen present in these brands.) Under certain circumstances and for certain purposes water-soluble nitrogen (particularly if in the nitrate form) is to be preferred agriculturally to organic nitrogen. It is more readily available, but also more easily lost by leaching.

All the nitrogen-containing brands (with one exception) contain more or less organic nitrogen. In 37 per cent of them this is the only form of this element, and is, no doubt, derived as a rule from standard animal and vegetable ammoniates such as blood, meat, fish, tankage, cottonseed meal, etc. Indeed the use of a method of analysis, confessedly somewhat imperfect, indicates that in general the sources of organic nitrogen have been of good grade. In a few cases, however, and notably with the goods of two companies selling in this state, the sources of organic nitrogen do not seem above suspicion. It is significant that the goods of these same companies ranked lower than did those of the others when similarly tested last year. (See pages 78-79.)

Several inferior if not worthless forms of organic nitrogen are for sale and known to be used to some extent in fertilizers. Chemistry is still powerless to detect these materials with certainty. Hence the buyer's best protection at present appears to lie in trading only with firms of the highest reputation, or in buying crude stock.

*Phosphoric Acid.* Some firms furnish relatively a larger proportion of the total phosphoric acid in available form than do others; and, again, some, more water-soluble acid relatively to the citrate-soluble (reverted) than do others. Water-soluble phosphoric acid cannot be other than of the best grade. Citrate-soluble phosphoric acid, while often, perhaps usually, quite as good (agriculturally) as that which is soluble in water, may be of distinctly lower grade (agriculturally) if certain classes of phosphatic crude stock be used. Low soluble and high reverted phosphoric acid contents do not of necessity mean that the available phosphoric acid is not agriculturally as valuable as when the conditions are reversed, but that the likelihood of this being true is lessened.

The proportions of the total phosphoric acid found in the various brands to be in available forms varied from 60 per cent to 95 per cent. The proportions of available phosphoric acid found to be in a water-soluble form varied from 25 per cent to 84 per cent. Grouped in accordance with manufacturers it was found that extremes for available in total were 70.5 and 90 per cents, for water-soluble in available, 45 and 74.5 per cents. In other words one of the firms selling in this state delivered on the average 90 per cent of the total phosphoric acid in its goods in available form, while another furnished but 70.5 per cent in that shape, the remainder ranging between. Similarly, on the average 74.5 per cent of the available phosphoric acid furnished by one manufacturer was soluble in water, while only 45 per cent was thus soluble in the case of another firm, the remainder ranging between. The latter figure (and others below 60) seem rather high. Whether due to the large use of incompletely dissolved bone or phosphate rock, or to the age of the goods, or to the use of (agriculturally) inferior forms of phosphoric acid or to other causes does not always appear.

*Potash.* Potash is sold in mixed goods in the forms of sulphate, muriate and kainit. The direct or inferential claim is made for nine-tenths of the brands sold in the state that sulphate of potash was used in manufacture. This claim is not, as a rule, borne out by the facts. Sixteen brands contained sulphate of potash; in every other case no sulphate was used, or else enough chlorin was found present to neutralize its good effects, if any. All but one of the companies selling in the state make general inferential claims regarding its use. One firm uses it in six brands, two others in two brands, six others in one brand apiece, the remainder not at all.

### AVAILABILITY OF ORGANIC NITROGEN.

The presence in fertilizers of inferior forms of organic nitrogen cannot be detected with certainty. There are, however, certain chemical methods which, while somewhat inadequate, furnish suggestive results of probable validity, although not of absolute exactness. Two of these, the pepsin-digestion and alkaline-permanganate distillation methods, have been used in the inspection work during the past three years. The latter was quite fully discussed last year in pages 161-171 of the eleventh report.

All of the brands collected this year (save those containing nitrate-nitrogen only) were tested with alkaline-permanganate, and several by pepsin. The results show but slight differences in the average organic nitrogen availability of goods selling at low, medium and relatively high figures. In general, however, the brands containing small amounts of nitrogen (less than one per cent) showed likewise low organic nitrogen availability. In other words quality as well as quantity of nitrogen was low as a rule in such brands.

The table shown below gives organic and total nitrogen availabilities of the average goods of each firm, each brand * analysed having equal value in the average. Thus for example if 9 brands made by one firm were analysed, the several organic and total nitrogen availabilities were each added, and the results divided by 9. The data is arranged in the general order of excellence; yet since no material difference exists between averages in several cases, no stress should be laid upon the exact order of statement. Inasmuch as the method used in determining the availability of organic nitrogen is empirical, and confessedly not absolutely correct, firm names are not given.

AVERAGE ORGANIC AND TOTAL NITROGEN AVAILABILITIES

| Per cent of organic nitrogen available by the alkaline-permanganate method | Per cent of total nitrogen available † | Per cent of organic nitrogen available by the alkaline-permanganate method | Per cent of total nitrogen available † |
|---|---|---|---|
| 63 | 69 | §48 | 71 |
| 62 | 68 | 58 | 61 |
| 62 | 67 | 59 | 59 |
| 61 | 66 | ‡49 | 65 |
| 61 | 64 | 57 | 60 |
| 59 | 65 | 56 | 59 |
| 60 | 62 | ‡51 | 51 |
| 59 | 62 | ‡46 | 58 |
| 58 | 64 | ‡46 | 46 |

* Those containing practically all the nitrogen as nitrate are omitted. Such goods are sold for special purposes and their nitrogen is obviously all available.

† Includes nitrogen as nitrates, as ammonia salts, and organic nitrogen available to permanganate.

The organic nitrogen in the goods marked § was apparently derived largely from vegetable matter. It was readily available to pepsin, and was undoubtedly of good grade. Alkaline-permanganate fails to do such goods entire justice. The quality of the organic nitrogen in the cases where the double dagger ‡ is used, seems somewhat doubtful. It is notable, moreover, that the two companies whose goods tailed the list last year, the organic nitrogen availability of which was then held to be "open to question, if not, indeed, to suspicion," bring up the rear again this year.

The result of the application of the pepsin-digestion method to these goods in general (case marked § excepted) confirmed the results obtained with alkaline-permanganate. No traces of leather could be detected, although such negative result means little since no good test is known. The chances are strong that inferior sources of organic nitrogen have entered into the manufacture of certain goods sold in the state in this and in preceding years; yet no definite proof of this statement can be furnished.

### 3. THE RELATION BETWEEN SELLING PRICES AND STATION VALUATION.

The relation of the selling prices of the various brands of commercial fertilizers to the money values of the plant food they contain is important. The emphasis laid thereon, however, should not lead the buyer to underrate the more important yet less easily stated agricultural value of the commercial fertilizer. The adaptation of the goods to the particular soil, and crop on which it is to be used and its value as a supplement to home manurial supplies should be paramount, and commercial considerations secondary. The station analyses are directly helpful in aiding the intelligent buyer in the selection of goods best fitted to meet his needs. Valuations, however, are not of use in this connection; indeed, in so far as they tend to distract the buyer's attention from the main to the subordinate phase of the problem, they are distinctly harmful and fail in their mission. They are not, however, without good reason for existence and serve as no other means can as measures of commercial worth, and as a common basis on which to compare various brands commercially. They indicate whether selling prices are justified by intrinsic commercial values, and indirectly serve in the more certain exposure of fraudulent goods, if such be sold.

Attention has been called to the fact that 77 per cent. of the goods sold this year contained the plant food they were guaranteed to furnish. This does not certify either the value of the goods or the wisdom of their purchase. It is simply fulfilling a guaranty which may have promised little or much. The law is complied with if promises are kept. It does not nor can it prevent exorbitant charges for plant food. Buyers often fail to note this point, that the maintenance of a guaranty does not insure adequate value for whatever price may be asked.

The multiplicity of brands and the ubiquity of the fertilizer agent afford a wide choice in all parts of the state. As a rule, moreover, the buyer of mixed goods can feel a fair degree of confidence in the quality of the raw material used by well established and reputable firms. Such being the case it is usually the part of wisdom to select from brands at hand and suitable to individual needs such as afford the most plant food for the dollar of cost, in other words, to study the relation of selling prices to the commercial values. An example, taken directly from the present bulletin, of four brands sold at the prices given in one community, may serve to make this point more clear. All having been considered suitable to the needs of the buyer, in view of analyses, crops and soil needs, supply of manure in hand, etc., etc., the question arises, which offers the most for the money :

| | Nitrogen | Available Phosphoric Acid | Potash | Selling price | Station valuation | Ratio of price to valuation |
|---|---|---|---|---|---|---|
| A. | 2. | 9 | 3 | $27 | $16.62 | 1 : .62 |
| B. | 2. | 8 | 3 | 26 | 15.92 | 1 : .60 |
| C. | 1.65 | 8 | 3 | 26.50 | 14.75 | 1 : .55 |
| D. | 1.65 | 8 | 3 | 27 | 14.57 | 1 : .54 |

In brand A is offered 62 cents worth of plant food* for a dollar as against 60, 55 and 54 cents worth in the other brands. The chances are that it would prove at least as satisfactory as either of the other brands and probably should be chosen.

Selling prices always exceed valuations, since the latter show only seaboard values of unmixed ingredients and do not include the other necessary and legitimate charges which accompany the manufacture and sale of mixed goods. If the selling price does not exceed the valuation more than 35 to 40 per cent it may not be too high, but in proportion as the excess increases beyond this point there is reason to question the economy of the purchase.

The relation of selling price to valuation in the goods of *different grades* is an important matter. Separating brands according to selling prices the following figures are obtained :

RELATION OF SELLING PRICES AND VALUATIONS OF THE AVERAGES, HIGHEST AND LOWEST OF DIFFERENT GRADES OF FERTILIZERS

| Selling price | Average selling price | Number of brands in group | Cents worth* of plant food at retail seaboard prices bought for a dollar at consumer's depot. | | | Number of brands in group which for a dollar furnish— | |
|---|---|---|---|---|---|---|---|
| | | | Highest | Lowest | Average | 55 cents or less worth* of plant food | 65 cents or more worth* of plant food |
| $27.00 and below | $25.48 | 61 | 68 | 44 | 56 | 32 | 9 |
| 27.50-32.00 | 28.96 | 47 | 82 | 50 | 61 | 9 | 13 |
| 33.00 and above | 36.26 | 28 | 75 | 46 | 66 | 2 | 19 |

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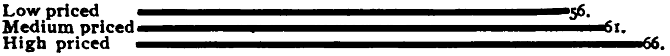
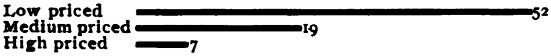
*The phrase "62 cents worth of plant food" should be construed to mean an amount of plant food which if bought for cash at retail at the seaboard would have cost 62 cents in standard unmixed raw materials.

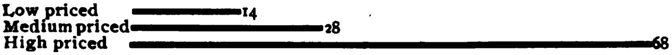
The comparison can be shown graphically. The relative lengths of the following lines show the average money value in plant food at retail seaboard prices bought for a dollar at Vermont delivery points in brands selling for $27 or less (low priced), from $27.50 to $32 (medium priced), and for $33 and above (high priced):



The following lines show the per cent of the total number of brands in each group containing 55 cents or less worth* of plant food for each dollar invested:



The final set of lines shows the per cent of the total number of brands in each group containing 65 cents or more worth* of plant food for each dollar invested:



If the lines and figures are put into words it will be seen that:

1. The same amounts of plant food which cost a dollar in the average low priced brands ($27 and below) might have been bought in the unmixed state at retail and at the seaboard for 56 cents; in the average medium priced goods ($27.50 to $32) for 61 cents; and in the average high priced goods ($33 and upwards) for 66 cents. Extremes of values were 82 cents and 44 cents. In nearly a third of the entire number of brands the charges for manufacture, sale, etc., were almost as great as or greater than the retail seaboard value of the plant food.

2. In over half of the number of low-priced goods, the charges for mixing, sale, etc., aggregated at least 45 per cent of the selling price, while in but one-fifth of the total number of medium priced brands and in but one-fourteenth of the high-priced goods were the costs as high as 45 per cent.

3. More than two-thirds of the total number of high-class goods contained an equivalent of 65 cents or more worth of plant food at retail seaboard prices, while less than one-third of the medium grades and less than one-sixth of the low-priced brands contained as high a relative value.

### LOW GRADE GOODS.

The tendency of the trade in Vermont is more and more in the direction of the larger purchase of low grade goods. The number of brands having nitrogen guaranties below 1.25 per cent found in the inspections of the last five years, have been 30, 33, 43, 45 and 47, respectively, or 33, 30, 32, 36 and 34 per cent of the entire number sold. These figures furnish no clue to amounts used, but judging by the statements of general agents and by the amounts of the various grades found by the station sampling agents, large quantities of low grade fertilizers are sold.

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*See foot note on opposite page.

There seem to be two main reasons for this trend of trade, one of which is good, the other, bad.

1. The percentage of nitrogen more than that of either of the other two ingredients determines the grade of the goods. Barnyard manure, largely made on dairy farms, is relatively rich in nitrogen, thus obviating the necessity of the purchase of that ingredient in large quantities.

2. Quantity rather than quality,—the most weight rather than the most plant food,—often determines choice. Ill-considered, haphazard purchase, guided by agents' claims, highsounding names and apparent cheapness, is far too frequent.

Low grade goods cost relatively high prices, because the costs of manufacture and sale are proportionately greater than those of medium or of high class. It costs as much to mix, bag, freight and sell inert material as similarly to handle plant food. One brand sold this year at $26 offered but 176 pounds of plant food, while another (containing similar amounts of nitrogen) guaranteed 376 pounds, yet was sold at but three dollars higher. Three dollars bought 200 pounds more phosphoric acid and potash, worth at market prices over $8.00. Brands were sold at $32 and $34 guaranteed to carry 386 and 410 pounds of plant food respectively, and containing relatively high proportions of nitrogen. From a quarter to a third larger expenditure bought 120 to 133 per cent more plant food and, likewise, far better balanced fertilizers. The brand first cited was not claimed to carry more than $8.85 worth of plant food, the others, $16.90, $22.10 and $22.70, or from twice to nearly thrice as much. The manufacturers of the low grade brand asked 66 cents for mixing, bagging, freighting, and selling 34 cents worth of plant food, while those who offered the higher priced fertilizer asked only half as much, 33 cents, for handling twice as much value in plant food, 67 cents worth.

There is, moreover, greater likelihood of inferior raw materials being used in the cheap than in the higher grades. The latter can be made only from the better classes of crude stock, which, if used in low grade goods, must of necessity be mixed with considerable quantities of inert material or "filler." Low priced brands offer the main outlet for certain kinds of raw materials which, because of their poor quality, could be less easily used in high class fertilizers.

The inference should not be drawn that all low priced goods are expensive and all high cost brands really cheap. There are extremes in each class. While in general it is true that the best are the cheapest, yet some low grade brands, provided they are made from good raw materials are not over expensive at the price asked, while some high priced fertilizers cost too much in proportion to the money value of the plant food they contain.

Brands low in nitrogen may frequently prove agriculturally successful if carefully selected, with a view of getting as large a money value as possible, and if used in connection with barn-yard manure, or on land already rich in nitrogen. In a great many cases, however, they are very likely to prove disappointing, more particularly because of the small proportions they contain of active nitrogen and of potash.

### SELECTION AND PURCHASE

The buyer of commercial fertilizers should view the matter from a different standpoint than does the station. The latter simply matches guaranty and analysis; the former studies his needs and compares them with the offerings of the seller, noting also the relation between prices asked and values given. The station in its inspection work is concerned simply with comparing the promises with the performances of the seller and with indicating the cash costs of equivalent amounts of plant food. The buyer, however, who wishes to make a rational choice and an economical purchase, while giving due weight to these points, needs also consider other matters involving careful farm management and wise business methods.

His *choice* between goods offered should be affected by the following considerations (not of necessity stated in the order of their relative importance.)

1. Results personally obtained or reported by reliable, careful, observing farmers on similar soils and crops.
2. The character, previous cropping and manuring of the soil.
3. The demands of the future crop for plant food.
4. The quality and amount of barn-yard manure available for use.
5. The fitness of the several goods (as judged by guaranties and analysis) for soil, crop and as a supplement to home manurial supplies.
6. The form in which the ingredients occur (nitrogen as nitrates, organic matter, etc., potash as muriate, sulphate, etc.).
7. Reputation of the firms offering goods.
8. The fact that brand names often mean little, are frequently misleading, and that guaranties (if kept) made by responsible firms are many times more valuable. (See pages 75–76.)

His *mode of purchase* of goods should be affected by the following conditions:

1. The relation of selling prices and station valuations. (See pages 79–81.)
2. The advantages and disadvantages, as compared with the purchase of "mixed goods" of:
   (a) Home-mixing. (See Bul. 47, pages 39–46; Bul. 65, pages 110–118.)

(b) The co-operative ordering, on competitive bids, of goods made from specified crude stock and of a definite grade and formula, bought and paid for on the basis of plant food delivered as determined by station analysis. (See remarks following.)

3. The advisability of buying concentrated by-products (cottonseed, linseed and gluten meals, etc.,) of growing leguminous crops more largely, being thus enabled to feed rations rich in protein; of using absorbents and "fixatives" (land plaster, kainit, etc.) in the stable, thus obtaining a more highly nitrogeous manure; in short, "fertilizing by feeding," buying less nitrogen in commercial fertilizers and more in fodder and feeds.

4. The choice of farm produce for sale with especial reference to its fertilizing content.

There hardly seems need of enlarging upon the conditions which govern choice, matters of which the buyer himself is usually the best judge. A fairly clear idea being gained as to the quality needed (which, it may be remarked, is of more importance than cheap buying) considerations arise as to economical purchase. There appear to be three methods, each perfectly feasible, which afford reasonable certainty as to the quality of the goods bought.

1. A brand of mixed goods may be bought which for years has held an essentially uniform composition and has regularly met its guaranty.
2. Crude stock of guaranteed composition may be bought and "home-mixed."
3. Goods may be bought on special order.

The reading matter and tables on pages 103–113 should prove helpful if the first named methods be adopted.

Bulletins 47 and 65 (sent to any address without charge, on request) cover quite thoroughly the matter of home-mixing, an easy and relatively cheap method of buying plant food. In the experience of several Vermont farmers in recent years, from 30 to 50 per cent more plant food has been bought at the same cost when crude stock was purchased instead of commercial brands. Field results were good and, in brief, *the practice paid.*

Buying goods on special order has much to recommend it to those who prefer to buy mixed goods rather than crude stock. Farmers, individually or collectively, get figures from several firms on definite amounts of fertilizers of guaranteed composition made from specified crude stock. They buy of the concern whose bid is lowest and pay for just the amount of plant food delivered as found on analysis by the experiment station. It is an eminently business-like method of purchase, fair to both parties, and one which many manufacturerers are willing to adopt.

In illustration of this method of buying plant food, may be cited the average result of 16 cases of special mixtures made to order by regular manufacturers as shown by Voorhees and Street.* The goods cost at the buyers' depot, $22.50, and contained $24.15 worth of plant food. The average mixed goods sold in the state that year cost $28.58 and "valued" $19.90. In the average material made on order and delivered, the plant food alone "valued" $1.65 more than its total cost; in the average commercial brand it "valued" $8.68 less than it cost. In each case mixed goods were delivered at the consumer's depot. The only differences in the transactions were that one lot was "made to order" and the other "ready-made," in the one case usually car load lots or more were sold for cash, and in the other, small amounts on time.

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* N. J. Exp. Sta., Bul. 132 pp, 16-18.

Van Slyke* reports similar results of co-operative buying by a Long Island agricultural society. Its members bought in 1898 in the form of a mixed fertilizer, made according to contract and delivered, nitrogen for 11.7 cents a pound, available phosphoric acid for 3.6 cents a pound, and potash as muriate for 3.75 cents a pound. These prices were but little more than half those paid for the same ingredients in mixed fertilizers bought in the ordinary way. The goods cost, delivered, $24.45 a ton; had they been bought at average prices in the usual fashion, they would have cost $44.67. The members of this club bought nearly 500 pounds of plant food for the same price that many Vermont farmers are to-day paying for less than 200 pounds. The 500 pounds, moreover, was of the best, while some of the 200 pounds is in some cases of doubtful quality.

Vermont farmers may make savings similar in kind (though not in extent, owing to their greater distance from factories and increased freight rates) by forethought, study and business enterprise. The fertilizer trade of the state approximates $400,000 annually. Three-fifths of this sum is spent for plant food and two-fifths reimburses the manufacturers for expenses.

It is probably true that the selling prices of mixed goods are not exorbitant, in view of the conditions of the trade, the agent and credit systems, etc. It is for the individual buyer, however, to say whether he needs pay two dollars out of every five in following a bad system of purchase, whether or not it is worth while to study his wants and the means of meeting them, whether co-operation and cash may not lessen his fertilizer bills without lowering the amount or the quality of the plant food he buys. The station at all times will gladly advise any parties to whom this plan of purchase may appeal.

## III. LICENSED FERTILIZERS SAMPLED BY STATION.

### H. J. Baker & Bro., New York, N. Y.

**G5. Complete Manure for General Use**; from stock of W. G. Appleby, Bennington.

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* N. Y. (Geneva) Exp. Sta., Bul. 145, p 58.

**H18. Complete Potato Manure**; from stock of Burditt Brothers, Rutland.

**H19. Complete Potato and Vegetable Manure**; from stock of A. J. Stevens, Winooski.

**G3. Complete Turnip Manure**; from stock of W. G. Appleby, Bennington.

**G4. Corn Manure**; from stock of E. Godfrey, Randolph.

### Bowker Fertilizer Co., Boston, Mass.

**H15. Corn Phosphate**; from stock of H. E. Kelly, Bradford.

**H21. Early Potato Manure**; from stock of E. M. Whitcomb, Essex Junction.

**F1. Farm and Garden Phosphate**; from stock ot W. C. Bugbee, Bridgewater.

**H14. Potash Bone**; from stock of L. J. Sanderson, Highgate.

**H13. Square Brand Bone and Potash**; from stock of A. E. Fuller, Woodstock.

**F3. Stockbridge Manure for Corn, Grain and Fodder Corn**; from stock of A. L. Aseltine, Swanton.

**F2. Stockbridge Manure for Onions**; from stock of A. L. Aseltine, Swanton.

**H16. Stockbridge Manure for Strawberries**; from stock of H. E. Kelly, Bradford.

**H11. Stockbridge Manure for Top Dressing**; from stock of H. E. Kelly, Bradford.

**H12. Superphosphate with Potash**; from stock of A. J. Brown, Springfield.

**F4. Ten Per Cent Manure**; from stock of A. L. Aseltine, Swanton.

**H10. Vermont Grange Chemicals, A Brand**; from stock of A. E. Fuller, Woodstock.

**H9. Vermont Phosphate**; from stocks of A. J. Brown, Springfield; L. J. Sanderson, Highgate.

### Bradley Fertilizer Co., Boston, Mass.

**H3. Complete Manure for Potatoes and Vegetables**; from stock of Valley Grain Co., Brattleboro.

**F5. Niagara Phosphate**; from stock of Maynard & Marsh, Sheldon.

**F6. Patent Superphosphate**; from stock of W. W. Coe, West Burke.

**F7. Strawberry Manure**; from stock of B. S. Hooker, Bradford.

### Clark's Cove Fertilizer Co , Boston, Mass.

**F8. Bay State Complete with Ten per cent Potash**; from stock of L. O. Brush, Underhill Center.

**G7. Triumph Bone and Potash**; from stock of Knight & Walker, West Brattleboоro.

### Cleveland Dryer Co., Boston, Mass.

**G13. High Grade Complete Manure**; from stock of M. A. Nelson, Montpelier.

**G11. Pioneer Fertilizer**; from stock of M. A. Nelson, Montpelier.

**G15. Special for Wheat, Rye and Oats**; from stock of M. A. Nelson, Montpelier.

**G14. Superphosphate**; from stock of D. Spooner, Randolph.

### E. Frank Coe Co., New York, N. Y.

**G11. Columbian Bone Superphosphate**; from stock of Farnsworth & Co., Middlebury.

**G8. Gold Brand Excelsior Guano**; from stock of F. A. Crane, Danville.

**G10. High Grade Ammoniated Bone Superphosphate**; from stock of L. F. Shonyo, Lyndonville.

**G12. New England Special for Corn** from stocks of F. A Crane, Danville; Silas Giddings, Castleton.

**G9. Red Brand Excelsior Guano**; from stock of L. F. Shonyo, Lyndonville.

### Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

**H20. Ammoniated Bone Superphosphate**; from stock of L. F. Fortney, Plainfield.

**F15 Special Potato Manure**; from stock of A. R. Wells, Newport.

**H2. Superior Fertilizer**; from stock of C. M. Byington, Charlotte.

### Cumberland Bone Phosphate Co , Boston, Mass.

**G1. Grass Fertilizer**; from stock of F. H. Frazier, West Burke.

**F12. Seeding Down Manure**; from stock of F. H. Frazier, West Burke.

### Lister's Agricultural Chemical Works, Newark, N. J.

**G18. Potato Fertilizer No. 2**; from stock of Geo. Bates, Springfield.

### Pacific Guano Co., Boston, Mass.

**G17. Soluble Pacific Guano with Ten per cent Potash**; from stock of L. D. Spooner, Randolph.

### Quinnipiac Co., Boston, Mass.

**H1. Grass Fertilizer**; from stock of E. H. Miller, Dummerston.

**G24. Market Garden Manure**; from stock of A. A. Duncklee, South Vernon.

**G23. Onion Manure**; from stock of A. A. Duncklee, South Vernon.

**G22. Potato Manure**; from stock of E. H. Miller, Dummerston.

**F16. Seeding Down Manure**; from stock of H. T. Ballard, East Poultney.

**G21. Special Manure with Ten per cent Potash**; from stock of F. J. Dean, Pawlet.

### Read Fertilizer Co., New York, N. Y.

**H8. Bone and Potash Fertilizer**; from stock of F. B. Gillette, Jonesville.

**H7. Corn, Wheat and Rye Fertilizer**; from stock of F. M. Morrill, New Haven Junction.

H5. **High Grade Farmers' Friend Fertilizer**; from stock of H. M. Taylor, New Haven Mills.

H6. **New York State Superphosphate**; from stock of W. M. Lewis, Orwell.

F9. **Sure Catch Fertilizer**; from stock of John Caucher, Lyndon.

H5. **Vegetable and Vine Fertilizer**; from stock of R. E. Beard, East Barre.

**Standard Fertilizer Co., Boston, Mass.**

F10. **Guano for All Crops**; from stock of J. H. Bushnell, Williston.

F11. **Special for Potatoes**; from stock of C. W. Atherton, Waterbury.

**H. F. Tucker Co., Boston, Mass.**

G20. **Original Bay State Fertilizer**; from stock of C. F. Wheeler Worcester.

G19. **Special Potato Fertilizer**; from stock of C. F. Wheeler, Worcester.

**Williams & Clark Fertilizer Co., Boston, Mass.**

F13. **Americus Ammoniated Bone Superphosphate**; from stock of H. S. Webster, East Burke.

H17. **Americus Potato Phosphate**; from stock of M. V. Willard, Jericho.

G2. **High Grade Special for Potatoes, Onions, Tobacco, Cabbage and Cauliflower**; from stock of J. Janes, Swanton.

### EXPLANATION OF THE TABLES OF ANALYSES

The figures in the tables of analyses of licensed fertilizers upon pages 89-100 show the per cents or parts per hundred found:

Column 1, of nitrogen derived from nitrate of soda; 2, of nitrogen derived from sulphate of ammonia; 3, of nitrogen derived from organic matter; 4, of total nitrogen, being columns 1, 2 and 3 added; 7, of phosphoric acid soluble in water; 8, of phosphoric acid insoluble in water but soluble in neutral ammonium citrate under the conditions specified in the footnote at the bottom of page 42 of Bulletin 69, and presumedly soluble in plant and root acids; 9, of phosphoric acid, insoluble in water or ammonium citrate, and but slowly available for plant uses; 10, of total phosphoric acid, being columns 7, 8 and 9 added; 12, of phosphoric acid readily available to the plant, being columns 7 and 8 added; 15, of potash soluble in water.

Columns 5, 11, 13 and 16 give respectively the percentages of nitrogen, total and available phosphoric acids and potash guaranteed to be present by the manufacturers.

Columns 6, 14 and 17 show respectively the retail cash cost at the seaboard of amounts of nitrogen, phosphoric acid and potash equal to those found in a ton of the fertilizer, the same being based on a careful study of the prices ruling in the large markets of the better forms of crude stock.

The *italicized* type gives *guarantees*, the **black-face** type gives the **most important figures found by analysis**.

# IV. ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| G 5... | Baker's Com. Manure for General Use | 0.41 | 1.00 | 1.37 | **2.72** | *2.47* | $7.69 | 4.50 | 3.60 | 1.38 | **9.48** | *9.* | **8.10** | *8.* | $ 7.48 | **7.10** | *6.* | $6.04 | G 5 |
| ‡H 18. | Baker's Complete Potato Manure.... | 0.45 | 1.27 | 2.20 | **3.92** | *3.3* | 11.09 | 4.98 | 1.81 | 0.72 | **7.51** | *6.75* | **6.79** | *5.75* | 6.22 | **10.59** | *10.* | 9.82 | H 18 |
| H 19. | Baker's Complete Potato and Veg..... | 0.25 | 0.99 | 1.40 | **2.64** | *2.47* | 7.51 | 5.91 | 3.41 | 1.13 | **10.45** | *7.* | **9.32** | *6.* | 8.50 | **6.92** | *5.* | 5.88 | H 19 |
| G 3... | Baker's Complete Turnip Manure ... | 0.91 | 2.24 | 2.84 | **5.99** | *5.75* | 16.95 | 1.42 | 3.92 | 0.29 | **5.63** | *6.* | **5.34** | *5.* | 4.53 | **9.20** | *9.* | 7.82 | G 3 |
| G 4... | Baker's Corn Manure.................... | 0.81 | 1.33 | 2.09 | **4.23** | *4.11* | 11.89 | 3.87 | 2.04 | 0.67 | **6.58** | *7.25* | **5.91** | *6.25* | 5.38 | **10.71** | *7.* | 9.10 | G 4 |
| E 2... | Baker's Harvest Home Fertilizer..... | 0.32 | ...... | 1.00 | **1.32** | *1.03* | 3.60 | 5.15 | 3.64 | 1.29 | **10.08** | *9.* | **8.79** | *8.* | 8.06 | **2.46** | *2.* | 2.09 | E 2 |
| E 16.. | Baker's Standard UnXLD Fertilizer.. | 0.48 | 0.35 | 1.30 | **2.13** | *1.85* | 5.89 | 7.45 | 1.95 | 0.53 | **9.93** | *9.* | **9.40** | *8.* | 8.48 | **3.05** | *2.25* | 2.59 | E 16 |
| H 15 | Bowker's Corn Phosphate ............... | 0.46 | ...... | 1.49 | **1.95** | *1.65* | 5.32 | 3.70 | 4.18 | 2.67 | **10.55** | *10.* | **7.88** | *8.* | 7.74 | **2.45** | *2.* | 2.08 | H 15 |
| H 21 | Bowker's Early Potato Manure....... | 1.16 | ...... | 2.34 | **3.50** | *3.29* | 9.45 | 5.93 | 2.49 | 2.43 | **10.85** | *9.* | **8.42** | *7.* | 8.30 | **7.39** | *7.* | 6.28 | H 21 |
| F 1... | Bowker's Farm and Garden Phos..... | 0.52 | ...... | 1.22 | **1.74** | *1.64* | 4.72 | 5.21 | 3.12 | 2.17 | **10.50** | *11.* | **8.33** | *9.* | 8.06 | **2.24** | *2.* | 1.90 | F 1 |
| C 3... | Bowker's Hill and Drill Phosphate.. | 0.70 | ...... | 2.02 | **2.72** | *2.47* | 7.41 | 7.59 | 2.99 | 2.21 | **12.79** | *12.* | **10.58** | *9.* | 10.11 | **2.46** | *2.* | 2.09 | C 3 |
| C 4... | Bowker's Market Garden Fertilizer.. | 0.85 | ...... | 1.65 | **2.50** | *2.47* | 6.75 | 5.49 | 2.88 | 2.83 | **11.20** | *8.* | **8.37** | *6.* | 8.38 | **9.97** | *10.* | 8.47 | C 4 |

*Potash in brands thus marked is largely if not entirely in the form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†"Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

‡Potash partly as sulphate.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| H 14 | Bowker's Potash Bone...... .............. | 0.29 | ...... | 0.55 | **0.84** | *0.82* | $2.27 | 1.91 | 4.35 | 2.67 | **8.93** | *8.* | **6.26** | *6.* | $6.27 | **2.88** | *2.* | $2.45 | H 14 |
| A 2... | Bowker's Potash or Staple Phosphate | 0.19 | ...... | 0.64 | **0.83** | *0.82* | 2.27 | 3.71 | 4.04 | 2.67 | **10.42** | *10.* | **7.75** | *8.* | 7.64 | **3.14** | *3.* | 2.67 | A 2 |
| D 1... | Bowker's Potato and Vegetable Phos. | 0.49 | ...... | 1.33 | **1.82** | *1.65* | 4.95 | 5.72 | 3.29 | 2.40 | **11.41** | *11.* | **9.01** | *9.* | 8.74 | **2.10** | *2.* | 1.79 | D 1 |
| H 13 | Bowker's Square Brand Bone & Pot. | 0.29 | ...... | 1.40 | **1.69** | *1.64* | 4.65 | 1.91 | 5.69 | 5.03 | **12.63** | *12.* | **7.60** | *6.* | 8.28 | **2.34** | *2.* | 1.99 | H 13 |
| E 3.. | Bowker's Stockbridge Corn Manure. | 1.33 | ...... | 2.09 | **3.42** | *3.29* | 9.18 | 6.11 | 2.04 | 2.38 | **10.53** | *10.* | **8.15** | *8.* | 8.08 | **7.45** | *7.* | 6.33 | E 3 |
| F 3... | Bowker's Stockbridge, Corn, Grain, &c | 1.46 | ...... | 1.80 | **3.26** | *3.29* | 8.69 | 6.06 | 2.27 | 2.40 | **10.73** | *10.* | **8.33** | *8.* | 8.23 | **7.59** | *7.* | 6.45 | F 3 |
| F 2... | Bowker's Stockbridge Onion Manure | 3.16 | ...... | 2.03 | **5.19** | *4.5* | 13.58 | 3.44 | 3.47 | 2.90 | **9.81** | *8.* | **6.91** | *6.* | 7.04 | **5.93** | *5.* | 5.04 | F 2 |
| E 4... | Bowker's Stockbridge Potato Manure | 1.32 | ...... | 2.11 | **3.43** | *3.29* | 9.21 | 4.71 | 1.96 | 2.76 | **9.43** | *8.* | **6.67** | *6.* | 6.91 | **10.22** | *10.* | 8.69 | E 4 |
| *H 16 | Bowker's Stock. Strawberry Manure | 0.60 | ...... | 2.05 | **2.65** | *2.47* | 7.24 | 7.58 | 3.50 | 1.87 | **12.95** | *12.* | **11.08** | *10.* | 10.37 | **4.13** | *4.* | 4.13 | H 16 |
| H 11 | Bowker's Stock. Top-Dres'ng Manure | 2.42 | ...... | 2.49 | **4.91** | *4.92* | 13.02 | 3.55 | 4.13 | 2.91 | **10.59** | *6.* | **7.68** | *5.* | 7.66 | **6.23** | *6.* | 5.29 | H 11 |
| H 12 | Bowker's Superphos. with Potash... | ...... | ...... | ...... | ...... | ...... | ...... | 4.21 | 6.82 | 3.07 | **14.10** | *12.* | **11.03** | *10.* | 10.48 | **3.25** | *1.* | 2.76 | H 12 |
| E 5... | Bowker's Sure Crop Phosphate........ | 0.19 | ...... | 0.89 | **1.08** | *0.82* | 2.97 | 5.47 | 3.66 | 2.75 | **11.88** | *11.* | **9.13** | *9.* | 8.95 | **2.30** | *2.* | 1.96 | E 5 |

*Potash in brands thus marked is largely if not entirely in the form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| F 4.. | Bowker's 10 per cent Manure ......... | 0.25 | ...... | 0.67 | **0.92** | *0.82* | $2.51 | 2.97 | 3.08 | 2.05 | **8.10** | *8.* | **6.05** | *6.* | $5.95 | **10 80** | *10.* | $9.18 | F 4 |
| H 10 | Bowker's Vt. Grange Chem. A Br'nd | 0.18 | ...... | 0.73 | **0.91** | *1.25* | 2.49 | 3.44 | 4.27 | 2.63 | **10.34** | *9.* | **7.71** | *8.* | 7.56 | **2 94** | *2.* | 2.50 | H 10 |
| A 1... | Bowker's Vt. Grange Chem. D Brand | 0.88 | ...... | 1.63 | **2.51** | *2.06* | 6.76 | 4.47 | 3.07 | 2.44 | **9.98** | *9.* | **7.54** | *8.* | 7.43 | **4.01** | *3.* | 3.41 | A 1 |
| E 6... | Bowker's Vermont Phosphate......... | 1.03 | ...... | 1.56 | **2.59** | *2.06* | 6.94 | 4.57 | 2.23 | 2.90 | **9.70** | *10.* | **6.80** | *8.* | 7.06 | **3.87** | *3.* | 3.29 | E 6 |
| ‡H 9.. | Bowker's Vermont Phosphate......... | 0.95 | ...... | 1.70 | **2.65** | *2.06* | 7.14 | 3.87 | 3.16 | 2.76 | **9.79** | *10.* | **7.03** | *8.* | 7.12 | **4.06** | *3.* | 3.45 | H 9 |
| H 3 .. | Bradley's Complete for Potatoes, etc | 0.40 | ...... | 2.97 | **3.37** | *3.3* | 9.31 | 5.84 | 1.66 | 1.85 | **9.35** | *9.* | **7 50** | *8.* | 7.33 | **7.97** | *7.* | 6.78 | H 3 |
| C 5... | Bradley's Complete 10% Potash...... | 0.18 | 0.17 | 2.59 | **2.94** | *3.3* | 8.21 | 5.41 | 2.67 | 1.87 | **9.95** | *7.* | **8.08** | *6.* | 7.75 | **10.17** | *10.* | 8.64 | C 5 |
| A 5... | Bradley's Corn Phosphate.............. | ...... | ...... | 2.09 | **2.09** | *2.06* | 5.85 | 4.77 | 4.28 | 2.51 | **11.56** | *10.* | **9.05** | *9.* | 8.72 | **1.60** | *1.5* | 1.36 | A 5 |
| A 13.. | Bradley's Eclipse Phosphate........... | 0.17 | ...... | 1.23 | **1.40** | *1.* | 3.87 | 5.14 | 3.94 | 3.27 | **12.35** | *12.* | **9.08** | *10.* | 9.09 | **1.61** | *1.5* | 1.37 | A 13 |
| *D 15.. | Bradley's English Lawn Dressing... | 4.86 | ...... | 0.04 | **4.90** | *4.95* | 12.26 | 1.51 | 4.66 | 1.82 | **7.99** | *6.* | **6.17** | *5.* | 5.82 | **2.79** | *2.5* | 2.75 | D 15 |
| F 5... | Bradley's Niagara Phosphate........... | ...... | ...... | 1.06 | **1.06** | *0.83* | 2.97 | 5.04 | 2.72 | 2.02 | **9.78** | *8.* | **7.76** | *7.* | 7.51 | **1.64** | *1.08* | 1.39 | F 5 |
| F 6... | Bradley's Patent Superphosphate...... | 0.53 | ...... | 1.89 | **2.42** | *2.05* | 6.62 | 6.86 | 2.80 | 1.80 | **11.46** | *11.* | **9.66** | *9.* | 9.13 | **2.29** | *2.* | 1.95 | F 6 |

*Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†"Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43–46.

‡Analyzed at request of manufacturers, who did not consider that E6 represented their goods.

# ANALYSES OF LICENSED FERTILIZERS.

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| A 12.. | Bradley's Potato Fertilizer............ | 0.19 | ...... | 1.97 | **2.16** | *2.06* | $6.00 | 4.79 | 3.93 | 2.51 | **11.23** | *11.* | **8.72** | *9.* | $8.46 | **3.51** | *3.25* | $2.98 | A 12 |
| E 14.. | Bradley's Potato Manure............... | 0.84 | ...... | 1.67 | **2.51** | *2.5* | 6.78 | 2.95 | 3.18 | 3.25 | **9.38** | *8.* | **6.13** | *6.* | 6.48 | **5.35** | *5.* | 4.55 | E 14 |
| F 7.... | Bradley's Strawberry Manure......... | 0.81 | ...... | 1.66 | **2.47** | *2.5* | 6.68 | 2.70 | 3.11 | 3.30 | **9.11** | *8.* | **5.81** | *6.* | 6.25 | **5.58** | *5.* | 4.74 | F 7 |
| A 4... | Bradley's Vermonter for all Crops... | 0.28 | ...... | 1.92 | **2.20** | *2.06* | 6.08 | 4.84 | 3.87 | 2.06 | **10.77** | *10.* | **8.71** | *8.* | 8.28 | **3.52** | *3.5* | 2.99 | A 4 |
| A 3... | Bradley's XL Superphosphate......... | 0.47 | ...... | 1.97 | **2.44** | *2.5* | 6.69 | 6.58 | 2.61 | 1.90 | **11.09** | *11.* | **9.19** | *9.* | 8.77 | **2.20** | *2.* | 1.87 | A 3 |
| ‡D 16.. | Bradley's XL Superphosphate......... | 0.49 | ...... | 2.01 | **2.50** | *2.5* | 6.86 | 5.36 | 4.52 | 4.10 | **13.98** | *11.* | **9.88** | *9.* | 10.08 | **2.09** | *2.* | 1.77 | D 16 |
| F 8.... | Clark's Cove Bay State Complete..... | 0.44 | ...... | 2.61 | **3.05** | *2.47* | 8.41 | 4.41 | 3.23 | 2.30 | **9.94** | *7.* | **7.64** | *6.* | 7.47 | **10.53** | *10.* | 8.95 | F 8 |
| E 9... | Clark's Cove Bay State Fert. G. G... | 0.50 | ...... | 1.87 | **2.37** | *1.85* | 6.49 | 5.78 | 3.50 | 2.59 | **11.87** | *10.* | **9.28** | *8.5* | 9.04 | **2.21** | *2.* | 1.88 | E 9 |
| E 10.. | Clark's Cove King Philip Alk. Gua.. | ...... | ...... | 1.25 | **1.25** | *1.03* | 3.50 | 4.89 | 3.38 | 2.40 | **10.67** | *9.* | **8.27** | *8.* | 8.07 | **2.33** | *2.* | 1.98 | E 10 |
| E 8... | Clark's Cove Potato Fertilizer......... | 0.46 | ...... | 1.70 | **2.16** | *2.06* | 5.91 | 5.88 | 2.99 | 3.00 | **11.87** | *9.* | **8.87** | *8.* | 8.88 | **3.29** | *3.* | 2.80 | E 8 |
| G 7 .. | Clark's Cove Triumph Bone & Potash | ...... | ...... | ...... | ...... | ...... | ...... .. | 8.11 | 2.45 | 1.33 | **11.89** | *11.* | **10.56** | *10.* | 9.79 | **2.24** | *2.* | 1.90 | G 7 |
| C 10.. | Cleveland Corn and Grain Phos...... | 0.33 | ...... | 1.74 | **2.07** | *2.06* | 5.70 | 3.89 | 4.22 | 4.20 | **12.31** | *10.5* | **8.11** | *9.5* | 8.56 | **1.62** | *1.5* | 1.38 | C 1 |

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†"Valuation" does not represent selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer ; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

‡Analyzed at request of manufacturers, who did not consider that A 3 represented their goods.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton † | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton † | |
| C 11.. | Cleveland Fertilizer for all Crops..... | ...... | ...... | 1.11 | **1.11** | *1.03* | $ 3 11 | 3.99 | 3.71 | 2.78 | **10.48** | *9.* | **7.70** | *8.* | $ 7.67 | **2.31** | *2.* | $1.96 | C 11 |
| G 13 | Cleveland High Grade Complete...... | 0.35 | ...... | 2.94 | **3.29** | *3.3* | 9.11 | 5.97 | 1.60 | 2.05 | **9.62** | *9.* | **7.57** | *8.* | 7.47 | **8.45** | *7.* | 7.16 | G 13 |
| G 16 | Cleveland Pioneer Fertilizer............ | ...... | ...... | 1.05 | **1.05** | *0.82* | 2.94 | 5.04 | 3.45 | 2.67 | **11.16** | *9.* | **8.49** | *7.* | 8.36 | **2.03** | *1.* | 1.73 | G 16 |
| A 10.. | Cleveland Potato Phosphate............ | 0.23 | ...... | 1.76 | **1.99** | *2.06* | 5.51 | 5.15 | 3.83 | 3.42 | **12.40** | *10.* | **8.98** | *8.* | 9.06 | **3.01** | *3.* | 2.56 | A 10 |
| G 15 | Cleveland Special for Wheat, Rye, etc | 0.28 | ...... | 1.04 | **1.32** | *0.82* | 3.61 | 5.21 | 3.23 | 2.47 | **10.91** | *9.* | **8.44** | *7.* | 8.26 | **2.25** | *1.* | 1.91 | G 15 |
| G 14 | Cleveland Superphosphate ............. | ...... | ...... | 1.79 | **1.79** | *2.05* | 5.02 | 5.91 | 3.46 | 2.85 | **12 22** | *11.* | **9.37** | *9.* | 9.23 | **2.14** | *2.* | 1.82 | G 14 |
| C 14.. | Coe's Cel. Spec. Grass and Grain...... | ...... | ...... | 0.86 | **0.86** | *0.83* | 2.41 | 5.60 | 3.59 | 2.68 | **11.87** | *10.5* | **9.19** | *8.5* | 8.98 | **1.79** | *1.5* | 1.52 | C 14 |
| *G 11 | Coe's Columbian Bone Superphos'te | ...... | ...... | 1.33 | **1.33** | *1.23* | 3.72 | 6.12 | 3.01 | 2.41 | **11.54** | *10.5* | **9.13** | *8.5* | 8.88 | **2.60** | *2.05* | 2.60 | G 11 |
| *A 7... | Coe's Columbian Corn Fertilizer...... | ...... | 0.13 | 1.14 | **1.27** | *1.2* | 3.58 | 5.90 | 3.53 | 2.39 | **11.82** | *10.5* | **9.43** | *8.5* | 9.09 | **2.66** | *2.5* | 2.66 | A 7 |
| *A 6... | Coe's Columbian Potato Fertilizer... | ...... | 0.12 | 1.13 | **1.25** | *1.2* | 3.52 | 6.39 | 3.08 | 1.99 | **11.46** | *10.5* | **9.47** | *8.5* | 9.02 | **2.53** | *2.5* | 2.53 | A 6 |
| *G 8 .. | Coe's Gold Brand Excelsior Guano.. | ...... | 0.18 | 2.37 | **2.55** | *2.5* | 7.18 | 6.38 | 2.84 | 1.50 | **10.72** | *9.* | **9.22** | *8.* | 8.61 | **6.01** | *6.* | 6.01 | G 8 |
| *G 10 | Coe's H. G. Ammo. Bone Superphos | ...... | 0.18 | 1.77 | **1.95** | *1.85* | 5.50 | 6.70 | 3.25 | 1.79 | **11.74** | *11.* | **9.95** | *9.* | 9.35 | **2 54** | *2.25* | 2.54 | G 10 |

* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43–46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton † | Soluble | Reverted | Insoluble | Total | | Available | | Valuation of Phosphoric Acid in One Ton † | Found | Guaranteed | Valuation of Potash in One Ton† | |
| | | | | | | | | | | | Found | Guaranteed | Found | Guaranteed | | | | | |
| G 12 | Coe's N. E. Special for Corn | ...... | ...... | 0.91 | **0.91** | *0.82* | $ 2.55 | 5.87 | 2.67 | 1.86 | **10.40** | *8.5* | **8 54** | *7.* | $ 8.16 | **3.18** | *3.* | $2.70 | G 12 |
| B 16.. | Coe's N. E. Special for Potatoes | ...... | ...... | 0.84 | **0.84** | *0.8* | 2.35 | 6.03 | 2.88 | 1.55 | **10.46** | *8.5* | **8 91** | *7.* | 8.36 | **3.23** | *3.* | 2.75 | B 16 |
| D 4... | Coe's Prize Brand Grass and Grain | ...... | ...... | ...... | ...... | ...... | ......... | 6.32 | 4.10 | 2.17 | **12.59** | *12.* | **10.42** | *10.5* | 9.84 | **2.36** | *2.* | 2.01 | D 4 |
| *G 9... | Coe's Red Brand Excelsior Guano | ...... | 0.60 | 2.45 | **3.05** | *3.4* | 8.65 | 7.45 | 2.19 | 1.19 | **10 83** | *10.* | **9.64** | *9.* | 8.93 | **5.65** | *6.* | 5.65 | G 9 |
| C 15.. | Coe's XXV Ammo. Bone Superphos | ...... | ...... | 1.00 | **1.00** | *0.8* | 2.80 | 6.36 | 3.45 | 1.90 | **11.71** | *9.* | **9.81** | *8.* | 9.23 | **1.83** | *1.5* | 1.56 | C 15 |
| E 15.. | Crocker's Ammo. Bone Superphos | ...... | ...... | 2.32 | **2 32** | *2.9* | 6.50 | 8.03 | 2.71 | 1.25 | **11.99** | *11.* | **10.74** | *10.* | 9.90 | **2.38** | *1.08* | 2.02 | E 15 |
| §H 20 | Crocker's Ammo. Bone Superphos | ...... | ...... | 2.34 | **2.34** | *2.9* | 6.55 | 9.06 | 2.49 | 1.90 | **13 45** | *11.* | **11·55** | *10.* | 10.91 | **1 18** | *1.08* | 1.00 | H 20 |
| A 14.. | Crocker's Ammo. Corn Phosphate | ...... | ...... | 2.03 | **2.03** | *2.* | 5.68 | 6.43 | 3.18 | 2.42 | **12.03** | *11.* | **9.61** | *10.* | 9.30 | **1.71** | *1.6* | 1.45 | A 14 |
| C 2... | Crocker's New Rival Ammo. Bone | ...... | ...... | 1.39 | **1.39** | *1.23* | 3.89 | 6.01 | 3.74 | 2.06 | **11.81** | *11.* | **9.75** | *10.* | 9.23 | **1.65** | *1.6* | 1.40 | C 2 |
| A 15.. | Crocker's Potato, Hop and Tobacco | ...... | ..... | 2.08 | **2.08** | *2.06* | 5.82 | 6.21 | 3.60 | 2.19 | **12.00** | *11.* | **9.81** | *10.* | 9.35 | **3.23** | *3.25* | 2.75 | A 15 |
| F 15.. | Crocker's Special Potato Manure | ...... | ...... | 4.20 | **4.20** | *3.7* | 11.76 | 4.33 | 2.99 | 3.92 | **11 24** | *9.* | **7.32** | *8.* | 7.87 | **4.05** | *5.4* | 3.43 | F 15 |
| ‡H 2.. | Crocker's Superior Fertilizer | ...... | ...... | 0.88 | **0.88** | *0.82* | 2.46 | 3.57 | 3.74 | 1.05 | **8.36** | *9.* | **7.31** | *8.* | 6.63 | **2.12** | *2.* | 1.80 | H 2 |

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‡ Also sold as "Superior Rye and Oats Fertilizer."

§ Analyzed at request of manufacturers, who did not consider that F 15 represented their goods.

# ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| D 3... | Cumberland Corn Fertilizer............ | 0.42 | ...... | 1.54 | 1.96 | *1.65* | $ 5.36 | 4.81 | 3.89 | 3.17 | 11.87 | *9.* | 8.70 | *8.* | $8.71 | 2.15 | *2.* | $1.83 | D 3 |
| D 2... | Cumberland Fertilizer for all Crops.. | ...... | ...... | 1.25 | 1.25 | *1.03* | 3.50 | 4.95 | 3.37 | 2.60 | 10.92 | *10.* | 8.32 | *8.* | 8.19 | 2.11 | *2.* | 1.79 | D 2 |
| *G 1... | Cumberland Grass Fertilizer........... | 4.18 | ...... | 0.32 | 4.50 | *3.9* | 11.35 | 2.17 | 3.40 | 2.24 | 7.81 | *6.* | 5.57 | *5.* | 5.57 | 3.07 | *2.* | 2.92 | G 1 |
| B 14.. | Cumberland Potato Fertilizer .... .... | 0.32 | ...... | 1.76 | 2.08 | *2.06* | 5.73 | 5.11 | 3.80 | 3.05 | 11.96 | *11.* | 8.91 | *9.* | 8.87 | 3.53 | *3.* | 3.00 | B 14 |
| F 12.. | Cumberland Seeding Down Manure | ...... | ...... | 1.14 | 1.14 | *1.03* | 3.19 | 5.51 | 2.86 | 2.05 | 10.42 | *10.* | 8.37 | *8.* | 8.07 | 2.43 | *2.* | 2.07 | F 12 |
| A 16.. | Cumberland Superphosphate........... | 0.19 | ...... | 1.76 | 1.95 | *2.06* | 5.40 | 4.95 | 5.16 | 2.50 | 12.61 | *10.* | 10.11 | *8.* | 9.58 | 2.08 | *2.* | 1.77 | A 16 |
| B 12.. | Great Eastern General Fertilizer...... | ...... | ...... | 0.98 | 0.98 | *0.82* | 2.74 | 6.40 | 2.75 | 1.75 | 10.90 | *9.* | 9.15 | *8.* | 8.66 | 4.06 | *4.* | 3.45 | B 12 |
| E 13.. | Great Eastern Grass and Oats Fert... | ...... | ...... | ...... | ...... | ...... | ......... | 4.96 | 6.42 | 1.57 | 12.95 | *12.* | 11.38 | *11.* | 10.23 | 1.85 | *2.* | 1.58 | E 13 |
| B 13.. | Great Eastern Northern Corn Spec'l | ...... | ...... | 2.88 | 2.88 | *3.* | 8.06 | 6.40 | 2.63 | 1.02 | 10.05 | *9.* | 9.03 | *8.* | 8.27 | 2.14 | *2.* | 1.80 | B 13 |
| C 7... | Great Eastern Potato Manure.......... | ...... | ...... | 2.10 | 2.10 | *2.06* | 5.88 | 6.44 | 2.24 | 0.97 | 9.65 | *9.* | 8.68 | *8.* | 7.98 | 4.05 | *4.* | 3.44 | C 7 |
| D 7... | Lister's Animal Bone and Potash..... | ...... | ...... | ...... | ...... | ...... | ......... | 4.78 | 4.91 | 1.28 | 10.97 | *10.* | 9.69 | *9.* | 8.74 | 5.21 | *5.* | 4.43 | D 7 |
| *D 5... | Lister's Lawn Fertilizer.................. | ...... | 1.44 | 0.54 | 1.98 | *1.65* | 5.83 | 5.26 | 2.61 | 0.42 | 8.29 | *8.* | 7.87 | *7.* | 6.99 | 3.89 | *3.5* | 3.89 | D 5 |

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| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | Station Number |
| *C 16.. | Lister's Oneida Special.................. | ...... | ...... | 0.79 | **0.79** | *0.62* | $ 2.21 | 7.37 | 3.06 | 1.95 | **12.38** | *11.* | **10.43** | *10.* | $ 9.86 | **1.22** | *1.* | $1.22 | C 16 |
| G 18 | Lister's Potato Fertilizer, No. 2....... | ...... | 0.26 | 1.44 | **1.70** | *1.81* | 4.82 | 7.46 | 2.72 | 2.12 | **12.30** | *12.* | **10.18** | *9.25* | 9.74 | **4.32** | *4.* | 3.67 | G 18 |
| D 6... | Lister's Special Corn Fertilizer....... | ...... | 0.18 | 1.45 | **1.63** | *1.65* | 4.60 | 4.75 | 3.69 | 3.28 | **11.72** | *9.* | **8.44** | *8.* | 8.54 | **3.26** | *3.* | 2.77 | D 6 |
| A 9.... | Lister's Special Potato Fertilizer...... | ...... | 0.12 | 1.58 | **1.70** | *1.65* | 4.78 | 4.88 | 3.15 | 3.30 | **11.33** | *9.* | **8.03** | *8.* | 8.23 | **3.00** | *3.* | 2.55 | A 9 |
| A 8... | Lister's Success Fertilizer.............. | ...... | 0.15 | 1.23 | **1.38** | *1.24* | 3.89 | 6.24 | 2.93 | 2.95 | **12.12** | *11.5* | **9.17** | *9.5* | 9.14 | **2.12** | *2.* | 1.80 | A 8 |
| ‡B 8.... | Lowell Swift's Animal Brand.......... | ...... | 0.25 | 2.49 | **2.74** | *2.47* | 7.72 | 7.26 | 2.00 | 1.10 | **10.36** | *10.* | **9.26** | *9.* | 8.57 | **4.17** | *4.* | 3.78 | B 8 |
| B 6... | Lowell Swift's Bone Fertilizer.......... | ...... | 0.13 | 1.82 | **1.95** | *1.65* | 5.49 | 4.74 | 2.96 | 1.74 | **9.44** | *9.* | **7.70** | *8.* | 7.34 | **3.26** | *3.* | 2.77 | B 6 |
| B 7... | Lowell Swift's D. Bone and Potash.. | ...... | ...... | 1.90 | **1.90** | *1.65* | 5.32 | 7.59 | 1.48 | 1.42 | **10.49** | *10.* | **9.07** | *9.* | 8.58 | **2.16** | *2.* | 1.84 | B 7 |
| *A 11 | Lowell Swift's Potato Phosphate...... | ...... | 0.15 | 2.36 | **2.51** | *2.47* | 7.06 | 6.34 | 2.47 | 1.01 | **9.82** | *9.* | **8.81** | *8.* | 8.09 | **6.27** | *6.* | 6.27 | A 11 |
| E 12.. | P. G. Co.'s Nobsque Guano............. | ...... | ...... | 0.70 | **0.70** | *1.15* | 1.96 | 5.18 | 3.58 | 2.25 | **11.01** | *9.* | **8.76** | *8.* | 8.43 | **2.06** | *2.* | 1.75 | E 12 |
| B 11.. | P. G. Co.'s Soluble Pacific Guano..... | 0.28 | ...... | 1.80 | **2.08** | *2.25* | 5.74 | 5.14 | 4.36 | 2.19 | **11.69** | *10.5* | **9.50** | *8.5* | 8.99 | **2.07** | *2.* | 1.76 | B 11 |
| G 17 | P. G. Co.'s Sol. Pac. Gu. 10% Potash | 0.63 | ...... | 2.28 | **2.91** | *2.47* | 7.97 | 4.27 | 3.55 | 2.50 | **10.32** | *7.* | **7.82** | *6.* | 7.68 | **10.14** | *10.* | 8.62 | G 17 |

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**‡ Potash partly as sulphate.**

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | Nitrogen | | | | | | Phosphoric Acid | | | | | | | | Potash | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| C 6... | P. G. Co.'s Potato Special.............. | ...... | 0.17 | 2.21 | 2.38 | *2.06* | $ 6.70 | 4.33 | 3.69 | 2.95 | 10.97 | *9.* | 8.02 | *8.* | $ 8.03 | 3.96 | *3.* | $3.37 | C 6 |
| B 5... | Quinnipiac Climax Phosphate......... | ...... | ...... | 1.04 | 1.04 | *1.03* | 2.91 | 5.20 | 3.31 | 2.41 | 10.92 | *9.* | 8.51 | *8.* | 8.29 | 2.62 | *2.* | 2.23 | B 5 |
| B 3... | Quinnipiac Corn Manure.................. | ...... | ...... | 1.95 | 1.95 | *2.06* | 5.46 | 4.97 | 4.32 | 2.65 | 11.94 | *10.* | 9.29 | *9.* | 8.99 | 1.73 | *1.5* | 1.47 | B 3 |
| *H 1.. | Quinnipiac Grass Fertilizer......... ... | 4.61 | ...... | 0.14 | 4.75 | *3.9* | 11.92 | 1.47 | 3.61 | 1.86 | 6.94 | *6.* | 5.08 | *5.* | 4.96 | 2.74 | *2.* | 2.68 | H 1 |
| G 24 | Quinnipiac Market Garden Manure.. | 0.35 | ...... | 3.04 | 3.39 | *3.3* | 9.39 | 6.10 | 1.81 | 1.94 | 9.85 | *9.* | 7.91 | *8.* | 7.71 | 7.87 | *7.* | 6.69 | G 24 |
| D 8... | Quinnipiac Mohawk Fertilizer......... | ...... | ...... | 0.84 | 0.84 | *0.82* | 2.35 | 3.62 | 4.14 | 3.59 | 11.35 | *8.* | 7.76 | *7.* | 8.00 | 1.87 | *1.* | 1.59 | D 8 |
| G 23.. | Quinnipiac Onion Manure .............. | 0.37 | ...... | 2.93 | 3.30 | *3.3* | 9.13 | 6.12 | 1.82 | 1.92 | 9.86 | *9.* | 7.94 | *8.* | 7.73 | 7.92 | 7. | 6.73 | G 23 |
| E 11.. | Quinnipiac Phosphate.................... | 0.59 | ...... | 1.97 | 2.56 | *2.47* | 6.99 | 6.65 | 2.65 | 2.06 | 11.36 | *10.* | 9.30 | *9.* | 8.93 | 2.26 | *2.* | 1.92 | E 11 |
| G 22.. | Quinnipiac Potato Manure.............. | ...... | 0.15 | 3.08 | 3.23 | *2.47* | 9.07 | 3.42 | 3.07 | 4.10 | 10.59 | *7.* | 6.49 | *6.* | 7.17 | 4.99 | *5.* | 4.24 | G 22 |
| B 4... | Quinnipiac Potato Phosphate........... | 0.14 | 0.14 | 1.78 | 2.06 | *2.05* | 5.75 | 4.97 | 3.57 | 3.02 | 11.56 | *9.* | 8.54 | *8.* | 8.54 | 3.19 | *3.* | 2.71 | B 4 |
| F 16.. | Quinnipiac Seeding Down Manure... | ...... | ...... | 1.05 | 1.05 | *0.82* | 2.94 | 5.10 | 3.34 | 2.69 | 11.13 | *10.* | 8.44 | *9.* | 8.34 | 2.17 | *2.* | 1.84 | F 16 |
| G 21.. | Quinnipiac Spec Manure 10% Potash | 0.24 | 0.14 | 2.42 | 2.80 | *2.47* | 7.80 | 5.04 | 1.67 | 2.42 | 9.13 | *7.* | 6.71 | *6.* | 6.85 | 10.11 | *10.* | 8.59 | G 12 |

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## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation [illegible] | [illegible] |
| H 8.. | Read's Bone and Potash ............ | ...... | ...... | ...... | ...... | ...... | $...... | 4.98 | 5.72 | 1.49 | **12.19** | *11.* | **10.70** | *10.* | $9.66 | **2.81** | *3.* | $2.3[illegible] | H [illegible] |
| H 7.. | Read's Corn, Wheat and Rye Fert... | ...... | ...... | 1.62 | **1.62** | *1.65* | 4.54 | 6.00 | 2.08 | 0.85 | **8.93** | *9.* | **8.08** | *8.* | 7.40 | **3.91** | *4.* | 3.32 | H 7 |
| C 12.. | Read's Farmers' Friend Superphos... | ...... | ...... | 2.04 | **2.04** | *2.06* | 5.71 | 6.29 | 3.78 | 1.18 | **11.25** | *11.* | **10.07** | *9.* | 9.16 | **2.02** | *2.* | 1.72 | C 12 |
| D 12.. | Read's Fish, Bone and Potash......... | ...... | ...... | 2.74 | **2.74** | *2.5* | 7.67 | 3.51 | 1.86 | 0.75 | **6.12** | *5.* | **5.37** | *4.* | 4.95 | **4.22** | *4.* | 3.59 | D 12 |
| H 5.. | Read's H. G. Farmers' Friend......... | ...... | ...... | 3.07 | **3 07** | *3.3* | 8.60 | 3.57 | 2.00 | 2.11 | **7.68** | *6.* | **5.57** | *5.* | 5.66 | **10.02** | *10.* | 8.52 | H 5 |
| B 20.. | Read's Leader Guano..................... | ...... | ...... | 0.98 | **0.98** | *0.83* | 2.74 | 4.58 | 3.05 | 0.86 | **8.49** | *8.* | **7.63** | *7.* | 6.91 | **2.02** | *2.* | 1.72 | B 20 |
| H 6.. | Read's New York State Superphos... | ...... | ...... | 1.61 | **1.61** | *1.23* | 4.51 | 6.00 | 3.05 | 3.27 | **12 32** | *10.* | **9.05** | *9.* | 9.15 | **2.58** | *2.* | 2.19 | H 6 |
| D 13.. | Read's Potato Manure..................... | ...... | ...... | 2.56 | **2.56** | *2.5* | 7.17 | 5.36 | 1.82 | 1.19 | **8 37** | *8.* | **7.18** | *7.* | 6.76 | **10.00** | *10.* | 8.50 | D 13 |
| B 18.. | Read's Practical Potato Special........ | ...... | ...... | 1.10 | **1.10** | *0.83* | 3.08 | 2.97 | 2.29 | 0.58 | **5.84** | *5.* | **5 26** | *4.* | 4.73 | **8.06** | *8.* | 6.85 | B 18 |
| B 17.. | Read's Sampson for Potatoes........... | ...... | ...... | 1.79 | **1.79** | *1.65* | 5.01 | 4.85 | 1.81 | 1.05 | **7.71** | *7.* | **6 66** | *6.* | 6.23 | **4.15** | *4.* | 3.53 | B 17 |
| B 19.. | Read's Standard Superphosphate..... | ...... | ...... | 1.02 | **1.02** | *0.83* | 2.86 | 5.98 | 2.35 | 1.00 | **9.33** | *9.* | **8.33** | *8.* | 7.66 | **4.23** | *4.* | 3.60 | B 19 |
| F 9... | Read's Sure Catch Fertilizer ........... | ...... | ...... | ...... | ...... | ...... | ...... | 2.97 | 4.35 | 0.90 | **8.22** | *7.* | **7.32** | *6.* | 6.54 | **4.25** | *4.* | 3.61 | F 9 |

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## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN | | | | | | PHOSPHORIC ACID | | | | | | | | POTASH | | | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total | | Available | | | | | | |
| | | From Nitrates | From Ammonia Sats | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Found | Guaranteed | Found | Guaranteed | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† | |
| H 4.. | Read's Vegetable and Vine Fertilizer | ...... | ...... | 1.93 | **1.93** | *1.65* | $ 5.40 | 4.86 | 2.06 | 0.74 | **7.66** | *7.* | **6.92** | *6.* | $ 6.31 | **6.73** | *8.* | $5.72 | H 4 |
| D 10.. | R. C. Co.'s Essex Corn Fertilizer..... | 0.46 | ...... | 2.00 | **2.46** | *2.* | 6.75 | 2.41 | 6.58 | 4.76 | **13.75** | *11.* | **8.99** | *9.* | 9.34 | **3.60** | *3.* | 3.06 | D 10 |
| B 1... | R. C. Co.'s Essex, Corn, Grain, Grass | 0.88 | ...... | 2.58 | **3.46** | *3.7* | 9.42 | 4.54 | 4.67 | 3.22 | **12.43** | *9.5* | **9.21** | *7.* | 9.11 | **10 23** | *9.5* | 8.70 | B 1 |
| *B 2... | R. C. Co.'s Essex, Potatoes and Roots | ...... | 0.71 | 2.83 | **3.54** | *3.7* | 10.05 | 4.63 | 4.96 | 2.94 | **12.53** | *9.* | **9.59** | *7.* | 9.31 | **8 97** | *8.5* | 8.82 | B 2 |
| D 11 | R. C. Co.'s Essex XXX Fish and Pot | ...... | ...... | 2.25 | **2.25** | *2.1* | 6.30 | 5.22 | 4.30 | 4.92 | **14.44** | *12.* | **9.52** | *9.* | 10.11 | **2.61** | *2.25* | 2.22 | D 11 |
| E 7... | Standard Fertilizer........................ | 0.39 | ...... | 1.77 | **2.16** | *2.06* | 5.93 | 4.45 | 3.92 | 3.25 | **11.62** | *10.* | **8.37** | *8.* | 8.44 | **2.18** | *2.* | 1.85 | E 7 |
| F 10.. | Standard Guano for All Crops......... | ...... | ...... | 1.05 | **1.05** | *1.03* | 2.94 | 5.13 | 2.99 | 2.67 | **10.77** | *10.* | **8.12** | *8.* | 8.11 | **2.24** | *2.* | 1.90 | F 10 |
| F 11.. | Standard Special for Potatoes ......... | 0.48 | ...... | 1.76 | **2.24** | *2.05* | 6.13 | 4.98 | 3.63 | 3.50 | **12.11** | *9.* | **8.61** | *8.* | 8.79 | **3.49** | *3.* | 2.97 | F 11 |
| C 8... | Tucker's Imperial for all Crops........ | ...... | ...... | 1.96 | **1.96** | *1.23* | 5.49 | 4.95 | 4.81 | 2.08 | **11.84** | *11.* | **9.76** | *9.* | 9.14 | **2 32** | *1.85* | 1.97 | C 8 |
| B 15.. | Tucker's Imperial for Corn............. | ...... | ...... | 1.75 | **1.75** | *1.23* | 4.90 | 5.12 | 3.51 | 2.55 | **11 18** | *11.* | **8.63** | *9.* | 8.44 | **2.60** | *1.85* | 2.21 | B 15 |
| C 9... | Tucker's Imperial for Potatoes......... | ...... | ...... | 1.80 | **1.80** | *1.23* | 5.04 | 4.63 | 4.08 | 2.32 | **11.03** | *11.* | **8.71** | *9.* | 8.36 | **2.47** | *1.85* | 2.10 | C 9 |
| G 20 | Tucker's Original Bay State Fert... .. | 0.38 | ...... | 1.62 | **2.00** | *2.06* | 5.48 | 3.80 | 4.51 | 3.15 | **11.46** | *11.* | **8.31** | *9.* | 8.29 | **2.29** | *2.* | 1.95 | G 20 |

* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

†"Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## ANALYSES OF LICENSED FERTILIZERS

| Station Number | BRAND | NITROGEN |  |  |  |  |  | PHOSPHORIC ACID |  |  |  |  |  |  |  | POTASH |  |  | Station Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | From Nitrates | From Ammonia Salts | From Organic Matter | Total Found | Total Guaranteed | Valuation of Nitrogen in One Ton† | Soluble | Reverted | Insoluble | Total |  | Available |  | Valuation of Phosphoric Acid in One Ton† | Found | Guaranteed | Valuation of Potash in One Ton† |  |
|  |  |  |  |  |  |  |  |  |  |  | Found | Guaranteed | Found | Guaranteed |  |  |  |  |  |
| G 19 | Tucker's Special Potato Fertilizer ... | 0.34 | ...... | 1.85 | **2.19** | *2.06* | $6.03 | 4.76 | 2.61 | 2.53 | **9.90** | *9.* | **7.37** | *8.* | $7.39 | **5.39** | *6.* | $4.58 | G 19 |
| F 13 | W. & C. Co.'s Amer. A. B. Super..... | 0.67 | ...... | 1.76 | **2.43** | *2.47* | 6.61 | 6.55 | 2.77 | 1.95 | **11.27** | *10.* | **9.32** | *9.* | 8.89 | **2.23** | *2.* | 1.90 | F 13 |
| C 1... | W. & C. Co.'s Americus Corn Phos.. | 0.25 | ...... | 2.03 | 2.28 | *2.06* | 6.31 | 4.15 | 4.09 | 3.11 | **11.35** | *10.* | **8.24** | *9.* | 8.25 | **1.68** | *1.5* | 1.43 | C 1 |
| B 9... | W. & C. Co.'s Americus Potato Man | ...... | 0.16 | 1.97 | 2.13 | *2.06* | 6.00 | 4.72 | 3.58 | 2.70 | **11.00** | *9.* | **8.30** | *8.* | 8.19 | **3.42** | *3.* | 2.91 | B 9 |
| H 17 | W. & C. Co.'s Amer. Potato Phos ... | 0.74 | ...... | 1.92 | 2.66 | *2.47* | 7.23 | 4.98 | 1.46 | 1.79 | **8.23** | *7.* | **6.44** | *6.* | 6.37 | **5.47** | *5.* | 4.65 | H 17 |
| G 2 .. | W. & C. Co.'s High Grade Special... | 0.81 | ...... | 2.42 | 3.23 | *3.3* | 8.83 | 4.66 | 3.86 | 2.33 | **10.85** | *9.* | **8.52** | *8.* | 8.21 | **7.90** | *7.* | 6.72 | G 2 |
| E 1... | W. & C. Co.'s Prolific Crop Producer | ...... | ...... | 1.05 | 1.05 | *0.82* | 2.94 | 3.37 | 4.06 | 3.07 | **10.50** | *7.* | **7.43** | *6.* | 7.51 | **1.18** | *1.* | 1.00 | E 1 |
| B 10.. | W. & C. Co.'s Royal Bone Phos....... | ...... | ...... | 1.35 | 1.35 | *1.03* | 3.78 | 5.37 | 3.54 | 2.32 | **11.23** | *8.* | **8.91** | *7.* | 8.59 | **2.53** | *2.* | 2.15 | B 10 |

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* Potash in brands thus marked is largely if not entirely in form of sulphate; in all others it is either as chlorid (muriate) or sufficient chlorin exists in the goods to account for all potash as such.

† "Valuation" does not represent proper selling price in Vermont, but the retail cash cost of amounts of plant food equal to that contained in a ton of the individual brand, in unmixed, standard raw materials at the seaboard. It does not of necessity state the commercial worth of a given fertilizer; neither is it a measure of its agricultural value. See "Commercial Value of Commercial Fertilizers," Bulletin 69, pages 43-46.

## V. COMPARATIVE VALUES OF FERTILIZERS LICENSED IN 1898 AND IN 1899.

Of the 157 brands of commercial fertilizers sold in the state during 1898 and 1899 and found by our sampling agents, 106 have been selected for a comparison of the characters of the goods sold under these brands in each of the two years. Only those brands have been chosen which have been found by the station sampling agents both years.

AVERAGE COMPOSITION OF FERTILIZERS IN 1898 AND 1899.

| Name of ingredient | 1898 | | 1899 | |
|---|---|---|---|---|
| | Pounds in a hundred | Valuation at 1899 prices | Pounds in a hundred | Valuation at 1899 prices |
| Nitrogen | 2.11 | $5 91 | 1.98 | $5 55 |
| Soluble Phosphoric Acid | 5.62 | 5 06 | 5.26 | 4 73 |
| Reverted Phosphoric Acid | 3.24 | 2 59 | 3.32 | 2 66 |
| Insoluble Phosphoric Acid | 2.06 | 0 82 | 2.25 | 0 90 |
| Available Phosphoric Acid | 8.86 | | 8.58 | |
| Total Phosphoric Acid | 10.92 | | 10.83 | |
| Potash | 3.69 | 3 14 | 3.71 | 3 15 |
| Total valuation per ton | | $17 52 | | $16 99 |

The commercial value of the average goods has lessened about 3 per cent this year as compared with last. While valuation has shrunk a half-dollar, average selling price has dropped only a quarter of a dollar, thus making plant food in average mixed goods cost a little more than last year.

The average nitrogen and available phosphoric acid percentages are lessened and potash figures remain unchanged.

The following table shows the averages for five years of analyses, selling prices, valuations, money value of plant food bought for a dollar, and valuations of all at 1899 trade values. All brands analyzed each year are included in the comparison, each brand being given equal value, which, while not strictly a correct method of calculation, is the best which can be done in the absence of data showing the consumption of individual brands. Inasmuch as high grade goods sell slowly and low grade brands readily, the actual average as used is probably much lower than that shown in the table.

AVERAGE ANALYSES, SELLING PRICES, VALUATIONS, ETC., 1895–1899.

| Year | Number of brands analyzed | Nitrogen | Phosphoric Acid |  |  |  |  | Potash | Average selling price | Average valuation at each year's trade value | Value of plant food received for each dollar paid out | Average valuation at 1899 trade values |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Soluble | Reverted | Insoluble | Total | Available |  |  |  |  |  |
| 1895 | 92 | 2.22 | 5.84 | 2.56 | 2.23 | 10.93 | 8.40 | 3.46 | $30.90 | $21.28 | 69 cts. | $17.47 |
| 1896 | 110 | 2.22 | 5.36 | 3.44 | 2.22 | 11.02 | 8.80 | 3.66 | 30.90 | 19.73 | 64 " | 17.79 |
| *1897 | 134 | 2.12 | 5.34 | 3.68 | 2.23 | 11.25 | 9.02 | 3.43 | 29.19 | 19.47 | 67 " | 17.59 |
| *1898 | 126 | 2.21 | 5.51 | 3.32 | 2.08 | 10.91 | 8.83 | 3.81 | 29.04 | 17.86 | 61 " | 17.86 |
| *1899 | 137 | 2.06 | 5.08 | 3.32 | 2.26 | 10.66 | 8.40 | 4.10 | 28.75 | 17.39 | 60 " | 17.39 |

The grade of goods sold is lower to-day, speaking commercially, than that sold 10 or 15 years ago. The average fertilizers of the past five years contain less nitrogen and available phosphoric acid, but more potash than formerly. Large numbers of low grade goods have lowered the former figure, while many brands rich with potash have served to raise the average for that ingredient. The trade conditions of the five years have been fairly uniform, the average grade has not changed materially and valuations on the same (1899) basis have varied less than 3 per cent.

Plant food is as cheap to-day to the consumer as it has been in the past; the prices asked for mixed goods, however, have not dropped in proportion to the decrease in the cost of raw materials. Good reasons exist for this condition. The expenses, over and above the cost of the unmanipulated plant food, entailed by the present system of manufacture and sale, are little if any lower now than they were in years gone by: hence they form a larger proportion of the total cost of commercial fertilizers than hitherto. Yet since on the average 40 cents on a dollar is paid for charges other than the retail cost of the plant food, a proportion larger than has been hitherto met, it follows that the buyer of mixed goods should observe the relation between selling price and valuation even more carefully than in the past. It is equally clear that the direct purchase of the raw materials (nitrate of soda, cottonseed meal, dried blood, tankage, dried ground fish, ground bone, acid phosphate, muriate of potash; sulphate of potash, etc.) for home-mixing, or buying on special order are proportionately more profitable to-day than ever before. Attention is called to the analyses of home-mixed fertilizers and the experience of Vermont farmers with the same as given in Bulletin 65. (Sent on application to any address without charge.)

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*Omitting 6 non-nitrogeneous goods analysed in 1897, 5 in 1898, and 7 in 1899, the nitrogen average of the former year becomes nearly the same as in 1895-96, that of 1898 becomes rather better, and that of 1899, 2.17 per cent. It also causes available phosphoric acid to drop from 0.05 to 0.10 per cent, while potash figures remain essentially unchanged.

## VI. ANALYSES FOR FIVE YEARS.

It often happens that the buyer of mixed goods must make his choice before the issuance of the analyses by the station. This station is able usually to distribute each year to its mailing list the analyses of some 35 or 40 brands about March 25, of as many more about April 25, and to put out it final bulletin containing the analyses of all brands sold in the state about May 30. Although these dates are far in advance of the issuance of similar figures by any other station north of the Potomac (being so because of the early dates of shipments into Vermont) the information as to the character of the goods of the current year often reaches the buyer too late to be of service; and if station analyses are consulted at all, those of the past year are used. These may or may not be safe guides. If, however, reference to analyses for successive years shows essential uniformity of composition in the past and if the guaranty statement remains unchanged, the buyer may feel fairly safe in assuming that former figures will be applicable.

In order to facilitate such reference and to indicate something of the evenness or variation in the composition from year to year of the several brands sold in the state, tables are given herewith showing the nitrogen, available phosphoric acid and potash percentages for the past five years of 133 brands* more commonly found. The table covers all brands found in any two or more years. Guaranties have been changed somewhat in certain brands from year to year, notably by one company.†

The guaranties printed in the tables are those for 1899. They are also those for the years 1895 to 1898 inclusive except where stated to the contrary in the numbered foot notes. Thus for example Bowker's Corn Phosphate is guaranteed to contain 1.65 per cent nitrogen and 8 per cent available phosphoric acid this year, but from 1895 to 1898 was guaranteed to carry from 1.5 and 9 per cent respectively of these ingredients. This is shown by the small figures in the tables against these years and by foot note. The asterisk * indicates that sulphate of potash was used as a source of potash, the dagger † that 0.20 per cent or more of nitrogen was present water-soluble shapes (as nitrate of soda, sulphate of ammonia or both.)

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*In a few cases minor changes of name have been made, as for example, from "Potato and Tobacco Phosphate" to "Potato Special," the guaranty remaining unaltered. In such cases the analyses of the goods bearing the old name are listed with those of later years under the present title.

†In the case of this particular company all but one of the changes have resulted in increasing the total amount of plant food guaranteed to be present. In the other cases the alterations have sometimes brought about an increase in the total plant food (and, often in the commercial worth of the plant food guaranteed to be present) but in rather more than half of the cases the guaranty changes have lessened the total plant food and probable values. It is perfectly proper for manufacturers to make alterations in the character of their goods if they see fit, and their legal duty is done when they call attention thereto in their changed guaranties. Some of these changes are quite serious in their nature and emphasize the wisdom of scanning the figures in addition to reading the name upon the bag. For example in one case goods were sold under a certain brand and guaranty one year and under the same name but a very different guaranty the next year, one which promised 5 per cent less plant food and over two dollars less commercial value.

It is thought that these tables, containing as they do the essentials of five years' inspection, ought to prove an aid in choosing goods for purchase, particularly those bought early in the season.

As a side-issue it may be noted that while many of these brands show essential uniformity from year to year, just such evenness of composition as is readily attained by careful manufacture, some brands vary quite widely one year with another although guaranties remain unaltered.

It is argued by some manufactures and agents that farmers, would-be "home-mixers," cannot make perfect mixtures and that factory-made goods are more even and uniform in composition. It does not seem impossible for farmers to attain the rather low standard of evenness of mixture shown by some of the brands cited in the tables. Indeed the publications of this as well as of many other stations clearly show that farmers can and do mix fertilizer crude stock at home as evenly as do many manufacturers. (See Bul. 65, pages 110–118.)

## ANALYSES OF LICENSED FERTILIZERS—1895–1899

| BRAND | NITROGEN | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Baker's Complete for General Use.. ......... | ...... | ...... | ...... | †2.72 | †2.72 | *2.47* | ...... | ...... | ...... | 9.11 | 8.10 | *8.* | ...... | ...... | ...... | 6.54 | 7.10 | *6.* |
| Baker's Complete Pot. and Veg. Manure .. | ...... | ...... | ...... | †2.79 | †2.64 | *2.47* | ...... | ...... | ...... | 7.48 | 9.32 | *6.* | ...... | ...... | ...... | 4.87 | 6.92 | *5.* |
| Baker's Complete Potato Manure .. ......... | ...... | ...... | ...... | †3.56 | †3.92 | *3.3* | ...... | ...... | ...... | 7.15 | 6.79 | *5.75* | ...... | ...... | ...... | *10.35 | *10.59 | *10.* |
| Baker's Harvest Home Fertilizer.... ......... | ...... | ...... | ...... | †1.34 | †1.32 | *1.03* | ...... | ...... | ...... | 9.11 | 8.79 | *8.* | ...... | ...... | ...... | 3.07 | 2.46 | *2.* |
| Baker's Standard UnXLD Fertilizer .. ....... | ...... | ...... | ...... | †2.15 | †2.13 | *1.85* | ...... | ...... | ...... | 9.23 | 9.40 | *8.* | ...... | ...... | ...... | 2.81 | 3.05 | *2.25* |
| Bowker's Corn Phosphate.... .................. | †[1] 1.81 | †[1] 1.93 | †[1] 1.78 | †[1] 1.93 | †1.95 | *1.65* | [1] 7.61 | [1] 8.77 | [1] 9.45 | [1] 8.47 | 7.88 | *8.* | 1.98 | 2.41 | 2.25 | 2.34 | 2.45 | *2.* |
| Bowker's Farm and Garden Phosphate..... | †1.91 | †1.87 | †1.78 | †1.81 | †1.74 | *1.64* | [2] 7.64 | [2] 8.49 | [2] 8.77 | [2] 8.68 | 8.33 | *9.* | 1.95 | 2.37 | 2.29 | 2.44 | 2.24 | *2.* |
| Bowker's Hill and Drill Phosphate ......... | †2.80 | †2.51 | †2.42 | †[3] 2.69 | †2.72 | *2.5* | 9.27 | 10.49 | 12.03 | 9.86 | 10.58 | *9.* | 2.29 | 2.46 | 2.39 | 2.47 | 2.46 | *2.* |
| Bowker's Market Garden Phosphate........ | ...... | †2.72 | †[3] 2.41 | †2.57 | †2.50 | *2.47* | ...... | 8.68 | 5.95 | 6.28 | 8.37 | *6.* | ...... | 10.70 | 11.10 | 10.73 | 9.77 | *10.* |
| Bowker's Potash Bone ........................... | . .... | ...... | [4] 0.98 | [4] 0.93 | †0.84 | *0.82* | ...... | ...... | [4] 4.89 | [4] 5.02 | 6.26 | *6.* | ...... | ...... | 2.31 | 2.25 | 2.88 | *2.* |
| Bowker's Potash or Staple Phosphate...... | ...... | †1.20 | 0.97 | †1.09 | 0.83 | *0.82* | ...... | 9.77 | 8.22 | 8.10 | 7.75 | *8.* | ...... | 3.67 | 3.31 | 3.35 | 3.14 | *3.* |
| Bowker's Potato and Vegetable Phosphate | †[5] 1.89 | †[5] 1.76 | †[5] 1.77 | †[5] 1.87 | †1.82 | *1.65* | [5] 8.40 | [5] 8.77 | [5] 8.42 | [5] 8.66 | 9.01 | *9.* | 2.21 | 2.45 | 2.09 | 2.27 | 2.10 | *2.* |
| Bowker's Square Brand Bone and Potash | 1.69 | †1.93 | †1.68 | ...... | †1.69 | *1.64* | 7.15 | 9.12 | 7.41 | ...... | 7.60 | *6.* | 3.23 | 2.31 | 2.23 | ...... | 2.34 | *2.* |
| Bowker's Stockbridge Corn Manure......... | †3.36 | †3.62 | †3.32 | †[6] 3.50 | †3.42 | *3.29* | 10.03 | 9.99 | 9.44 | 9.11 | 8.15 | *8.* | [7] 4.80 | [7] 4.51 | [8] 7.39 | [8] 7.54 | 7.45 | 7. |

[1] Nitrogen guaranty, 1.5; available phosphoric acid guaranty, 9.
[2] Available phosphoric acid guaranty, 8.
[3] Nitrogen guaranty, 2.25.
[4] Nitrogen guaranty, 0.75; available phosphoric acid guaranty, 5.
[5] Nitrogen guaranty, 1.5; available phosphoric acid guaranty, 8.
[6] Nitrogen guaranty, 3.
[7] Potash guaranty, 4.
[8] Potash guaranty, 6.

## ANALYSES OF LICENSED FERTILIZERS—1895-1899.

| BRAND | NITROGEN | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Bowker's Stockbridge Onion Manure | ...... | ...... | † 5.28 | ...... | † 5.19 | *4.5* | ...... | ...... | 6.94 | ...... | 6.91 | *6.* | ...... | ...... | 6.87 | ...... | 5.93 | *5.* |
| Bowker's Stockbridge Potato Manure | † 3.24 | † 3.17 | † 3.40 | † 3.48 | † 3.43 | *3.29* | 8.67 | [9] 5.68 | [9] 8.33 | [9] 7.59 | 6.67 | *6.* | [10] 7.37 | 9.71 | 10.44 | 10.26 | 10.22 | *10.* |
| Bowker's Stockbridge Seeding-Down Man | † 2.50 | † 2.58 | † [11] 2.17 | † [11] 2.60 | ...... | *2.47* | [12] 7.33 | [12] 8.70 | [12] 6.96 | [12] 6.73 | ...... | *8.* | 10.89 | 9.88 | 10.12 | 9.61 | ...... | *10.* |
| Bowker's Stockbridge Strawberry Manure | † 2.61 | † 2.60 | ...... | † 2.72 | † 2.65 | *2.5* | [13] 10.09 | [13] 10.26 | ...... | [13] 10.44 | 11.08 | *10.* | 4.27 | 3.72 | ...... | 4.13 | 4.13 | *4.* |
| Bowker's Stockbridge Top-Dress'g Man're | † 5.38 | † 5.11 | † 4.89 | † [14] 5.01 | † 4.91 | *4.92* | [15] 5.57 | [15] 6.31 | [15] 6.66 | [15] 6.72 | 7.68 | *5.* | 6.34 | 6.61 | 6.62 | 6.63 | 6.23 | *6.* |
| Bowker's Superphosphate with Potash | ...... | ...... | ...... | ...... | ...... | ...... | 9.29 | 10.21 | ...... | ...... | 11.03 | *10.* | 1.89 | 1.22 | ...... | ...... | 3.25 | *1.* |
| Bowker's Sure Crop Phosphate | † [16] 1.16 | † [16] 1.14 | † [16] 1.06 | [16] 0.99 | 1.08 | *0.82* | [16] 7.37 | [16] 9.97 | [16] 9.54 | [16] 10.50 | 9.13 | *9.* | [16] 1.14 | [16] 1.28 | [16] 1.46 | [16] 1.19 | 2.30 | *2.* |
| Bowker's 10 per cent Manure | † 1.21 | † 1.00 | ...... | ...... | † 0.92 | *0.82* | 3.89 | [17] 6.20 | ...... | ...... | 6.05 | *6.* | 10.53 | 10.18 | ...... | ...... | 10.80 | *10.* |
| Bowker's Vt. Grange Chem. A Brand | ...... | † 1.97 | ...... | ...... | 0.91 | *1.25* | ...... | 9.32 | ...... | ...... | 7.71 | *8.* | ...... | 2.90 | ...... | ...... | 2.94 | *2.* |
| Bowker's Vt. Grange Chem. D Brand | ...... | † 2.42 | † 2.33 | † 2.67 | † 2.51 | *2.06* | ...... | 10.77 | 9.54 | 8.55 | 7.54 | *8.* | ...... | 4.45 | 4.08 | 4.44 | 4.01 | *3.* |
| Bowker's Vermont Phosphate | ...... | † 2.54 | † [18] 2.25 | † [18] 2.56 | † 2.62 | *2.06* | ...... | 10.82 | 8.46 | 9.41 | 6.92 | *8.* | ...... | 4.71 | 3.71 | 4.58 | 3.97 | *3.* |
| Bradley's B. D. Sea Fowl Guano | 2.16 | † 2.26 | † 2.12 | 2.16 | ...... | *2.05* | 9.57 | 10.31 | 9.85 | 8.70 | ...... | *8.* | 2.12 | 1.45 | 1.88 | 1.71 | ...... | *1.5* |
| Bradley's Complete Corn and Grain | ...... | † 3.25 | † 3.46 | ...... | ...... | *3.3* | ...... | 9.72 | 9.17 | ...... | ...... | *12.* | ...... | 6.63 | 5.54 | ...... | ...... | *3.* |
| Bradley's Complete Potato and Vegetable | † [19] 3.48 | ...... | † [19] 3.71 | † 3.16 | † 3.37 | *3.3* | 8.53 | ...... | 8.46 | 9.04 | 7.50 | *8.* | [19] 5.77 | ...... | [19] 6.15 | 7.27 | 7.97 | *7.* |
| Bradley's Complete 10 per cent. Potash | ...... | ...... | ...... | † 3.31 | † 2.94 | *3.3* | ...... | ...... | ...... | 7.90 | 8.08 | *6.* | ...... | ...... | ...... | 9.39 | 10.17 | *10.* |

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**[9] Available phosphoric acid guaranty, 5.**
**[10] Potash guaranty, 7.**
**[11] Nitrogen guaranty, 2.25.**
**[12] Available phosphoric acid guaranty, 6.**
**[13] Available phosphoric acid guaranty, 6.**
**[14] Nitrogen guaranty, 4.75.**
**[15] Available phosphoric acid guaranty, 4.**
**[16] Former guaranty, nitrogen, 0.75; available phosphoric acid, 8; potash, 1.**
**[17] Available phosphoric acid guaranty, 5.**
**[18] Nitrogen guaranty, 1.75.**
**[19] Nitrogen guaranty, 3.7; potash guaranty, 6.**

ANALYSES OF LICENSED FERTILIZERS—1895-1899.

| BRAND | NITROGEN. | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Bradley's Complete Top Dressing | †5.09 | †5.13 | †5.41 | †5.08 | ...... | *4.95* | 5.16 | 5.16 | 5.24 | 7.12 | ...... | *5.* | 3.70 | *2.89 | *3.05 | *2.85 | ...... | *2.5* |
| Bradley's Corn Phosphate | 2.28 | †2.33 | †2.32 | 2.07 | 2.09 | *2.06* | 9.16 | 8.91 | 9.59 | 9.76 | 9.05 | *9.* | 2.02 | 1.72 | 1.82 | 1.74 | 1.60 | *1.5* |
| Bradley's Eclipse Phosphate | 2.28 | 1.93 | 1.89 | 1.67 | 1.40 | *1.03* | 9.54 | 9.66 | 9.11 | 10.48 | 9.08 | *10.* | 1.86 | 1.49 | 1.60 | 1.78 | 1.61 | *1.5* |
| Bradley's English Lawn Dressing | ...... | †5.05 | †4.95 | †5.00 | †4.90 | *4.95* | ...... | 5.70 | 6.17 | 6.14 | 6.17 | *5.* | ...... | *2.88 | *2.78 | *2.91 | *2.79 | *2.5* |
| Bradley's Patent Superphosphate | ...... | 2.38 | 2.37 | 2.52 | †2.42 | *2.05* | ...... | 9.39 | 10.35 | 10.11 | 9.66 | *9.* | ...... | 2.39 | 1.82 | 2.16 | 2.29 | *2.* |
| Bradley's Potato Fertilizer | †2.28 | 2.23 | 2.47 | 2.18 | 2.16 | *2.05* | 8.81 | 9.06 | 9.03 | 9.07 | 8.72 | *9.* | 3.38 | 3.06 | 3.62 | 3.49 | 3.51 | *3.25* |
| Bradley's Potato Manure | †2.53 | 2.68 | †2.47 | †2.69 | †2.51 | *2.5* | 6.11 | 6.17 | 6.44 | 6.10 | 6.13 | *6.* | 5.31 | 5.43 | 5.38 | 5.23 | 5.35 | *5.* |
| Bradley's Seeding Down Fertilizer | ...... | †2.12 | ...... | 1.76 | ...... | *1.65* | ...... | 9.02 | ...... | 8.80 | ...... | *5.* | ...... | 2.03 | ...... | 1.30 | ...... | *1.08* |
| Bradley's Seeding Down Manure | †2.89 | †2.95 | 2.76 | ...... | ...... | *2.5* | 9.22 | 10.61 | 10.45 | ...... | ...... | *7.* | 2.45 | 2.26 | 2.12 | ...... | ...... | *2.* |
| Bradley's Strawberry Manure | ...... | †2.62 | ...... | ...... | †2.45 | *2.5* | ...... | 6.85 | ...... | ...... | 5.79 | *6.* | ...... | 5.16 | ..... | ...... | 5.58 | *5.* |
| Bradley's Vermonter for all Crops | ...... | †2.28 | 2.24 | 2.11 | †2.20 | *2.06* | ...... | 9.33 | 8.73 | 9.79 | 8.71 | *8.* | ...... | 3.09 | 4.56 | 4.60 | 3.52 | *3.5* |
| Bradley's XL Superphosphate of Lime | †2.53 | †2.88 | 2.55 | 2.52 | †2.47 | *2.5* | 9.56 | 9.46 | 10.11 | 10.50 | 9.55 | *9.* | 2.58 | 2.08 | 1.86 | 2.08 | 2.15 | *2.* |
| Clark's Cove Bay State Fertilizer G. G. | 2.28 | 2.23 | 2.20 | 2.15 | †2.37 | *1.85* | 8.81 | 8.39 | 9.26 | 9.21 | 9.28 | *8.5* | 2.70 | 2.19 | 2.06 | 2.37 | 2.21 | *2.* |
| Clark's Cove King Philip Alkaline Guano | ...... | 1.25 | 1.30 | 1.20 | 1.25 | *1.03* | ...... | 8.24 | 8.58 | 8.67 | 8.27 | *8.* | ...... | 2.54 | 2.00 | 2.36 | 2.33 | *2.* |
| Clark's Cove Potato Fertilizer | 2.16 | †2.14 | 2.32 | 2.11 | †2.16 | *2.06* | 8.11 | 9.14 | 8.96 | 8.52 | 8.87 | *8.* | 3.37 | 3.31 | 3.62 | 2.96 | 3.29 | *3.* |

## ANALYSES OF LICENSED FERTILIZERS—1895-1899

| BRAND | NITROGEN |  |  |  |  |  | AVAILABLE PHOSPHORIC ACID |  |  |  |  |  | POTASH |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Cleveland Corn and Grain Phosphate.. ... | †2.42 | †2.17 | 2.30 | 2.10 | +2.07 | *2.06* | 9.02 | 8.80 | 9.33 | 9.38 | 8.11 | *9.5* | 1.90 | 1.62 | 1.69 | 1.60 | 1.62 | *1.5* |
| Cleveland Fertilizer for all Crops.... ......... | 1.53 | 1.18 | 1.25 | 1.16 | 1.11 | *1.03* | 8.13 | 7.99 | 8.74 | 8.45 | 7.70 | *8.* | 2.16 | 2.28 | 2.39 | 2.33 | 2.31 | *2.* |
| Cleveland High Grade Complete......... .... | ...... | +3.35 | +3.50 | +3.32 | +3.29 | *3.3* | ...... | 8.57 | 8.84 | 8.62 | 7.57 | *8.* | ...... | 6.59 | 6.81 | 7.29 | 8.45 | *7.* |
| Cleveland Pioneer Fertilizer.......... ........ | ...... | ...... | 1.06 | 1.16 | 1.05 | *0.82* | ...... | ...... | 7.95 | 8.22 | 8.49 | *7.* | ...... | ...... | 1.26 | 1.48 | 2.03 | *1.* |
| Cleveland Potato Phosphate.......... ........ | 2.14 | +2.26 | 2.17 | 2.11 | +1.99 | *2.06* | 8.77 | 7.91 | 9.64 | 8.87 | 8.98 | *8.* | 3.23 | 3.00 | 3.22 | 3.30 | 3.01 | *3.* |
| Cleveland Seeding Down Fertilizer........ .. | ...... | ...... | 1.93[20] | 1.11 | ...... | *1.03* | ...... | ...... | 6.66[20] | 8.97 | ...... | *8.* | ...... | ...... | 2.35 | 2.33 | ...... | *2.* |
| Cleveland Special for Wheat, Rye & Oats .. | ...... | ...... | 1.37 | ...... | 1.32 | *0.82* | ...... | ...... | 8.43 | ...... | 8.44 | *7.* | ...... | ...... | 1.21 | ...... | 2.25 | *1.* |
| Cleveland Superphosphate.. .......... ......... | 2.26 | +2.10 | 2.15 | 1.99 | +1.77 | *2.05* | 9.25 | 9.06 | 9.15 | 9.19 | 9.37 | *9.* | 2.52 | 2.41 | 2.00 | 2.15 | 2.14 | *2.* |
| Coe's Cel. Special for Grass and Grain...... | 1.11 | 1.23 | 1.08 | 1.13 | 0.86 | *0.83* | 9.79 | 9.62 | 10.84 | 11.15 | 9.19 | *9.* | *1.64 | *1.54 | *1.59 | *1.81 | 1.79 | *1.35* |
| Coe's Cel, Special Potato Fertilizer.......... | 2.05 | 1.77 | +1.71 | +1.94 | ...... | *1.65* | 10.10[21] | 9.71[21] | 10.13[21] | 9 53 | ...... | *8.* | *3.24[21] | *3.74[21] | *3.44[21] | *3.77 | ...... | *4.* |
| Coe's Columbian Ammoniated Bone......... | 1.82 | 1.56 | 1.56 | 1.55 | 1.33 | *1.23* | 9.20[22] | 9.53[22] | 10.39[22] | 10.69[22] | 9.13 | *8.5* | *1.90[22] | *2.29[22] | *1.75[22] | *2.16[22] | *2.60 | *2.5* |
| Coe's Columbian Corn Fertilizer............. | 1.54 | +1.90 | 1.44 | 1.51 | 1.27 | *1.23* | 9.47[22] | 8.67[22] | 10.24[22] | 10.83[22] | 9.43 | *8.5* | *1.86[22] | *2.24[22] | *1.82[22] | *2.06[22] | *2.66 | *2.5* |
| Coe's Columbian Potato Fertilizer.......... | 1.60 | +1.56 | 1.52 | 1.53 | 1.25 | *1.23* | 9.22[22] | 8.79[22] | 10.09[22] | 10.64[22] | 9.47 | *8.5* | *1.74[22] | *2.08[22] | *1.96[22] | *1.98[23] | *2.53 | *2.5* |
| Coe's Excelsior Potato Fertilizer............. | †2.80[23] | +2.89 | +2.77 | +2.77 | ...... | *2.5* | 7.07[23] | 8.53 | 8.05 | 7.67 | ...... | *8.* | *8.70[23] | *7.65 | *7.25 | *8.16 | ...... | *8.* |
| Coe's Gold Brand Excelsior Guano.......... | †2.58 | +2.70 | +2.61 | ...... | 2.55 | *2.5* | 8.47 | 8.49 | 8.27 | ...... | 9.22 | *8.* | 5.24 | *6.25 | *5.69 | ...... | *6.01 | *6.* |

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[20] Nitrogen guaranty, 1.65; available phosphoric acid guaranty, 5.

[21] Available phosphoric acid guaranty, 9; potash guaranty, 3.5.

[22] Available phosphoric acid guaranty, 9; potash guaranty, 1.85.

[23] 1895 guaranty, nitrogen 3.3; available phosphoric acid, 7; potash, 9.

## ANALYSES OF LICENSED FERTILIZERS—1895-1899

| BRAND | NITROGEN | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Coe's Ground Bone and Potash | …… | 2.02 | 2.05 | 2.04 | …… | *2.* | …… | 8.46 | 10.05 | 10.47 | …… | …… | …… | 2.69 | 2.64 | 2.78 | …… | *2.5* |
| Coe's H. G. Ammo. Bone Superphosphate | † 2.16[24] | 2.25[24] | 1.96[24] | † 2.19[24] | 1.95 | *1.85* | 9.30 | 9.33 | 9.83 | 10.16 | 9.75 | *9.* | * 1.87[24] | * 2.15[24] | * 1.73[24] | * 2.30[24] | * 2.54 | *2.25* |
| Coe's N. E. Special for Corn | …… | …… | …… | 1.17 | 0.91 | *0.82* | …… | …… | …… | 10.41[25] | 8.54 | *7.* | …… | …… | …… | * 2.25[25] | 3.18 | *3.* |
| Coe's N. E. Special for Potatoes | …… | …… | …… | 1.18 | 0.84 | *0.82* | …… | …… | …… | 10.44[25] | 8.91 | *7.* | …… | …… | …… | * 2.17[25] | 3.23 | *3.* |
| Coe's Red Brand Excelsior Guano | † 3.38 | † 3.26[26] | † 3.51 | † 3.50 | † 3.02 | *3.4* | 7.85 | 8.22[26] | 8.49 | 8.92 | 9.64 | *9.* | * 6.16 | * 5.95 | * 5.91 | * 6.41 | * 5.63 | *6.* |
| Coe's S. G. Ammo. Bone Superphosphate | 1.81 | † 2.00 | 1.89 | 1.79 | …… | *1.75* | 9.41 | 8.81 | 10.24 | 10.53 | …… | *8.* | * 1.60 | * 1.62 | * 1.52 | * 1.50 | …… | *1.35* |
| Coe's XXV Ammo. Bone Superphosphate | …… | 1.14 | 1.07 | 1.16 | 1.00 | *1.* | …… | 8.89 | 11.21 | 11.61 | 9.81 | *8.* | …… | * 1.09 | * 1.08 | * 1.03 | 1.83 | *1.* |
| Crocker's Ammo. Bone Superphosphate | …… | † 2.79 | 2.70 | 3.13 | 2.33 | *2.9* | …… | 10.58 | 10.97 | 10.66 | 11.15 | *10.* | …… | 1.39 | 1.39 | 1.19 | 1.78 | *1.08* |
| Crocker's Ammo. Corn Phosphate | 2.18 | 2.32 | 2.14 | 2.09 | 2.03 | *2.* | 10.19 | 10.60 | 10.46 | 10.13 | 9.61 | *10.* | 1.92 | 2.19 | 1.79 | 1.87 | 1.71 | *1.6* |
| Crocker's New Rival Ammo. Bone | 1.44 | 1.42 | 1.35 | 1.32 | 1.39 | *1.23* | 10.22 | 9.51 | 10.27 | 10.47 | 9.75 | *10.* | 1.81 | 1.91 | 1.92 | 1.80 | 1.65 | *1.6* |
| Crocker's Potato, Hop and Tobacco | 2.10 | 2.14 | 2.22 | 2.28 | 2.08 | *2.06* | 10.17 | 10.13 | 11.01 | 10.00 | 9.81 | *10.* | 3.52 | 3.56 | 3.56 | 3.32 | 3.23 | *3.25* |
| Crocker's Special Potato Manure | …… | 3.87 | 4.04 | † 3.77 | 4.20 | *3.7* | …… | 8.18 | 8.24 | 8.99 | 7.06 | *8.* | …… | 5.75 | 5.17 | 5.24 | 4.14 | *5.4* |
| Crocker's Superior Rye and Oats Fertilizer | 1.34 | 1.14 | 1.06 | 0.85 | 0.88 | *0.82* | 8.36 | 7.82 | 9.09 | 8.17 | 7.31 | *8.* | 1.98 | 2.01 | 1.94 | 2.10 | 2.12 | *2.* |
| Cumberland Fertilizer for all Crops | 1.30 | 1.18 | 1.21 | 1.10 | 1.25 | *1.03* | 7.69 | 8.07 | 8.48 | 8.47 | 8.32 | *8.* | 2.59 | 2.34 | 2.12 | 2.33 | 2.11 | *2.* |
| Cumberland Potato Fertilizer | † 2.11 | † 2.12 | 2.24 | † 2.07 | † 2.08 | *2.06* | 8.51 | 9.20 | 9.11 | 9.14 | 8.91 | *9.* | 3.33 | 3.23 | 3.30 | 2.98 | 3.53 | *3.* |

[24] Nitrogen guaranty, 2.06; potash guaranty, 1.85.
[25] Available phosphoric acid guaranty, 9; potash guaranty, 2.15.
[26] Nitrogen guaranty, 3; available phosphoric acid guaranty, 8.

## ANALYSES OF LICENSED FERTILIZERS—1895–1899

| BRAND. | NITROGEN. | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Cumberland Seeding Down Manure......... | 1.42 | [27] 1.28 | 1.29 | 1.16 | 1.14 | *1.03* | 8.07 | [27] 8.43 | 8.52 | 8.49 | 8.37 | *8.* | 2.47 | [27] 2.45 | 2.00 | 2.46 | 2.43 | *2.* |
| Cumberland Superphosphate................... | †2.43 | †2.28 | 2.24 | †2.26 | 1.95 | *2.06* | 9.12 | 8.02 | 9.45 | 10.10 | 10.11 | *8.* | 2.36 | 2.36 | 1.93 | 2.22 | 2.08 | *2.* |
| Great Eastern General Fertilizer............. | 1.20 | †0.96 | 1.08 | 1.05 | 0.98 | *0.82* | 7.59 | 8.37 | 8.11 | 8.72 | 9.15 | *8.* | 3.86 | 4.31 | 4.13 | 4.37 | 4.06 | *4.* |
| Great Eastern General Oats Fertilizer...... | ...... | ...... | ...... | ...... | ...... | ...... | 11.84 | 11.05 | 10.98 | 10.78 | 11.38 | *11.* | 1.57 | 2.36 | 2.12 | 2.10 | 1.85 | *2.* |
| Great Eastern Northern Corn Special....... | ...... | †2.92 | †3.04 | †3.06 | 2.88 | *3.* | ...... | 8.60 | 8.56 | 9.07 | 9.03 | *8.* | ...... | 2.29 | 2.41 | 2.29 | 2.14 | *2.* |
| Great Eastern Potato Manure................... | ...... | †2.33 | 2.13 | 2.38 | 2.10 | *2.06* | ...... | 8.33 | 8.46 | 8.43 | 8.68 | *8.* | ...... | 4.30 | 4.21 | 4.28 | 4.05 | *4.* |
| Lister's Animal Bone and Potash ........... | ...... | ...... | ...... | ...... | ...... | ...... | 9.22 | 9.62 | 9.46 | 9.65 | 9.69 | *9.* | 4.99 | 5.37 | 5.12 | 4.90 | 5.21 | *5.* |
| Lister's Oneida Special........................... | ...... | ...... | ...... | 0.91 | 0.79 | *0.62* | ...... | ...... | ...... | 10.75 | 10.43 | *10.* | ...... | ...... | ...... | 1.12 | 1.22 | *1.* |
| Lister's Potato Fertilizer No. 2................. | †2.58 | 2.21 | †1.91 | ...... | †1.68 | *1.81* | 9.85 | 10.72 | 10.37 | ...... | 10.18 | *9.25* | 3.97 | 4.53 | 4.50 | ...... | 4.32 | *4.* |
| Lister's Potato Manure............................. | 3.72 | †3.99 | †3.71 | †3.68 | ...... | *3.7* | 7.96 | 7.98 | 8.86 | 8.55 | ...... | *7.5* | 7.52 | 7.46 | 7.46 | 6.83 | ...... | *7.* |
| Lister's Special Corn Fertilizer................. | ...... | ...... | ...... | 1.80 | 1.63 | *1.65* | ...... | ...... | ...... | 8.89 | 8.44 | *8.* | ...... | ...... | ...... | 3.05 | 3.26 | *3.* |
| Lister's Special Potato Fertilizer............. | †1.89 | †1.93 | †1.75 | 1.81 | 1.70 | *1.65* | 8.48 | 9.03 | 9.31 | 8.84 | 8.03 | *8.* | 2.90 | 3.46 | 3.82 | 3.17 | 3.00 | *3.* |
| Lister's Success Fertilizer........................ | †1.65 | †1.58 | †1.54 | 1.45 | 1.38 | *1.25* | [28] 8.99 | [28] 9.48 | 11.55 | 9.99 | 9.17 | *9.5* | 2.01 | 2.21 | 2.21 | 2.66 | 2.12 | *2.* |
| Lowell Swift's Animal Brand.................. | ...... | †2.81 | 2.58 | 2.59 | †2.74 | *2.47* | ...... | [29] 7.78 | 10.93 | 9.08 | 9.26 | *9.* | ...... | 4.07 | 3.19 | 4.05 | 4.17 | *4.* |
| Lowell Bone Fertilizer............................ | ...... | †[30] 2.53 | 1.80 | 1.79 | 1.95 | *1.65* | ...... | [30] 8.58 | 7.42 | 8.31 | 7.70 | *8.* | ...... | 3.96 | 2.80 | 3.33 | 3.26 | *3.* |

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[27] 1896 guaranty nitrogen 0.82; available phosphoric acid, 7; potash, 1.

[28] Available phosphoric acid guaranty, 9.

[29] Available phosphoric acid guaranty, 7.

[30] Nitrogen guaranty, 2.47; available phosphoric acid guaranty, 5.

## ANALYSES OF LICENSED FERTILIZERS—1895–1899

| BRAND. | NITROGEN. | | | | | | AVAILABLE PHOSPHORIC ACID. | | | | | | POTASH. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Lowell Swift's Dis. Bone and Potash........ | ...... | ...... | 1.68 | 1.91 | 1.90 | *1.65* | ...... | ...... | 7.84 | 9.05 | 9.07 | *9.* | ...... | ...... | 2.38 | 2.24 | 2.16 | *2.* |
| Lowell Potato Phosphate........................ | ...... | †3.42[31] | ...... | 2.86 | 2.51 | *2.47* | ...... | 11.88[31] | ...... | 8.65 | 8.81 | *8.* | ...... | 5.91 | ...... | •6.08 | •6.27 | *6.* |
| Pacific Guano Co.'s Nobsque Guano......... | 1.33 | 1.25 | 1.32 | 1.16 | 0.70 | *1.15* | 7.56 | 8.60 | 8.49 | 8.51 | 8.76 | *8.* | 2.42 | 2.10 | 2.25 | 2.11 | 2.06 | *2.* |
| Pacific Guano Co.'s Potato Special........... | †2.31 | †2.37 | 2.20 | 2.09 | 2.38 | *2.06* | 8.27 | 8.26 | 8.89 | 9.38 | 8.02 | *8.* | 3.27 | 3.16 | 3.34 | 3.22 | 3.96 | *3.* |
| Pac. Guano Co.'s Soluble Pacific Guano.... | 2.37 | †2.21 | 2.37 | 2.13 | †2.08 | *2.25* | 8.71 | 9.36 | 9.28 | 9.40 | 9.50 | *8.5* | 2.53 | 2.37 | 1.93 | 2.21 | 2.07 | *2.* |
| Quinnipiac Climax Phosphate................ | 1.27 | 1.18 | 1.29 | 1.24 | 1.04 | *1.03* | 8.21 | 8.03 | 8.38 | 8.69 | 8.51 | *8.* | 2.54 | 2.16 | 2.23 | 2.25 | 2.62 | *2.* |
| Quinnipiac Corn Manure........................ | †2.22 | †2.33 | †2.25 | 2.10 | 1.95 | *2.06* | 8.99 | 8.68 | 9.01 | 9.79 | 9.29 | *9.* | 1.94 | 1.52 | 1.77 | 1.63 | 1.73 | *1.5* |
| Quinnipiac Market Garden Manure......... | †3.47 | ...... | †3.32 | †3.57 | †3.39 | *3.3* | 8.49 | ...... | 9.63 | 8.66 | 7.91 | *8.* | 6.59 | ...... | 6.66 | 7.48 | 7.87 | *7.* |
| Quinnipiac Mohawk Fertilizer................. | ...... | ...... | ...... | 1.17 | 0.84 | *0.82* | ...... | ...... | ...... | 7.86 | 7.76 | *7.* | ...... | ...... | ...... | 1.48 | 1.87 | *1.* |
| Quinnipiac Onion Manure...................... | ...... | ...... | ...... | †3.39 | †3.30 | *3.3* | ...... | ...... | ...... | 8.46 | 7.94 | *8.* | ...... | ...... | ...... | 7.48 | 7.92 | *7.* |
| Quinnipiac Phosphate........................... | †3.05 | †2.86 | †2.57 | 2.45 | †2.56 | *2.47* | 8.86 | 9.93 | 10.92 | 10.41 | 9.30 | *9.* | 2.58[32] | 2.16 | 2.02 | 2.05 | 2.26 | *2.* |
| Quinnipiac Pine Island Phosphate.......... | ...... | 2.10 | 2.22 | ...... | ...... | *2.06* | ...... | 8.87 | 9.40 | ...... | ...... | *9.* | ...... | 2.63 | 2.25 | ...... | ...... | *1.* |
| Quinnipiac Potato Manure...................... | †2.51 | †2.72 | 2.48 | ...... | 3.23 | *2.47* | 5.91 | 6.51 | 7.43 | ...... | 6.49 | *6.* | 4.82 | 5.33 | 5.38 | ...... | 4.99 | *5.* |
| Quinnipiac Potato Phosphate.................. | †2.31 | †2.42 | 2.47 | 2.23 | †2.06 | *2.06* | 8.15 | 8.76 | 9.05 | 9.48 | 8.54 | *8.* | 2.85 | 2.81 | 3.64 | 3.28 | 3.19 | *3.* |
| Quinnipiac Seeding Down Manure.......... | ...... | 1.16 | 1.21 | ...... | 1.05 | *0.82* | ...... | 8.55 | 8.76 | ...... | 8.44 | *9.* | ...... | 2.05 | 2.40 | ...... | 2.17 | *2.* |

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[31] Nitrogen guaranty, 3.29; available phosphoric acid guaranty, 7.

[32] Potash guaranty, 2.5.

## ANALYSES OF LICENSED FERTILIZERS—1895–1899

| BRAND | NITROGEN 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | AVAILABLE PHOSPHORIC ACID 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | POTASH 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Read's Corn, Wheat and Rye | ...... | † [32a] 1.75 | [32a] 1.15 | ...... | 1.62 | *1.65* | ...... | 8.66 | 9.13 | ...... | 8.08 | *8.* | ...... | [32a] 1.87 | [32a] 1.21 | ...... | 3.90 | *4.* |
| Read's Farmers' Friend Superphosphate | † 2.31 | † 2.20 | 2.25 | 2.39 | 2.04 | *2.06* | 8.93 | 9.83 | 9.64 | 10.11 | 10.07 | *9.* | 2.18 | 2.03 | 2.27 | 2.60 | 2.02 | *2.* |
| Read's Fish, Bone and Potash | 2.63 | 2.75 | † 2.74 | 2.30 | 2.74 | *2.47* | 4.90 | 5.31 | 4.47 | 4.44 | 5.37 | *4.* | 4.91 | 4.43 | 4.54 | 4.31 | 4.22 | *4.* |
| Read's Leader Guano | 1.18 | 1.11 | 1.10 | 1.13 | 0.98 | *0.83* | 6.82 | 7.35 | 7.46 | 7.27 | 7.63 | *7.* | 2.43 | 2.48 | 2.73 | 2.30 | 2.02 | 2. |
| Read's Practical Potato Special | ...... | 1.23 | 1.09 | 1.08 | 1.10 | *0.83* | ...... | 4.52 | 4.49 | 4.58 | 5.26 | *4.* | ...... | 8.49 | 8.20 | 8.38 | 8.06 | *8.* |
| Read's Sampson for Potatoes | ...... | ...... | ...... | 2.32 | 1.79 | *1.65* | ...... | ...... | ...... | 8.36 | 6.66 | *6.* | ...... | ...... | ...... | 4.82 | 4.15 | *4.* |
| Read's Standard Superphosphate | † 1.23 | † 1.20 | 1.15 | 1.09 | 1.02 | *0.83* | 7.97 | 7.90 | 8.23 | 8.72 | 8.33 | *8.* | 4.09 | 4.70 | 3.36 | 4.02 | 4.23 | *4.* |
| Read's Sure Catch Fertilizer | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 7.75 | 7.16 | 7.32 | *6.* | ...... | ...... | 5.14 | 4.06 | 4.25 | *4.* |
| Read's Vegetable and Vine Fertilizer | ...... | 1.95 | ...... | 1.91 | 1.93 | *1.65* | ...... | 6.59 | ...... | 6.42 | 6.92 | *6.* | ...... | 8.00 | ...... | 8.41 | 6.73 | *8.* |
| Russia C. Co.'s Essex Corn, Grain & Grass | ...... | ...... | † 4.07 | † 4.28 | † 3.46 | *3.7* | ...... | ...... | 9.07 | 8.51 | 9.21 | *7.* | ...... | ...... | 9.88 | 9.89 | 10.23 | *9.5* |
| Russia C. Co.'s Essex Potatoes & Roots | ...... | ...... | † 4.36 | † 4.38 | † 3.54 | *3.7* | ...... | ...... | 8.76 | 8.59 | 9.59 | *7.* | ...... | ...... | * 9.08 | * 8.90 | * 8.97 | *8.5* |
| Russia C. Co.'s Essex XXX Fish & Potash | ...... | ...... | 2.65 | 2.50 | 2.25 | *2.1* | ...... | ...... | [33] 9.91 | [33] 9.54 | 9.52 | *9.* | ...... | ...... | 2.55 | 2.32 | 2.61 | *2.25* |
| Russia C. Co.'s High Grade Superphos. | ...... | ...... | † 2.98 | † 2.98 | ...... | *2.5* | ...... | ...... | 10.53 | 9.76 | ...... | *9.* | ...... | ...... | 4.72 | 4.80 | ...... | *4.* |
| Standard Fertilizer | † 2.29 | † 2.18 | 2.13 | † 2.19 | † 2.16 | *2.06* | 8.14 | 8.86 | 9.58 | 9.10 | 8.37 | *8.* | 2.36 | 2.33 | 1.92 | 2.22 | 2.18 | *2.* |
| Standard Guano for all Crops | † 1.48 | 1.24 | 1.28 | 1.14 | 1.05 | *1.03* | 8.31 | 8.34 | 8.70 | 8.06 | 7.97 | *8.* | 2.43 | 2.29 | 2.17 | 2.35 | 2.24 | *2.* |

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[32a] Nitrogen guaranty 0.83, potash guaranty 1.

[33] Available phosphoric acid guaranty, 10.

# ANALYSES OF LICENSED FERTILIZERS—1895—1899

| BRAND | NITROGEN | | | | | | AVAILABLE PHOSPHORIC ACID | | | | | | POTASH | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. | 1895 | 1896 | 1897 | 1898 | 1899 | Guar. |
| Standard Special for Potatoes | †2.25 | 2.29 | 2.12 | 2.09 | †2.24 | *2.05* | 8.46 | 9.24 | 9.53 | 9.67 | 8.61 | *8.* | 3.36 | 3.01 | 2.92 | 3.36 | 3.49 | *3.* |
| Tucker's Imperial for all Crops | ...... | [34] 1.79 | [34] 2.16 | 1.29 | 1.96 | *1.23* | ...... | 9.66 | 8.45 | 8.69 | 9.76 | *9.* | ...... | 1.65 | 2.07 | 2.25 | 2.32 | *1.85* |
| Tucker's Imperial for Corn | ...... | ...... | [34] 2.12 | 1.32 | 1.75 | *1.23* | ...... | ...... | 8.97 | 8.58 | 8.63 | *9.* | ...... | ...... | 1.92 | 2.30 | 2.60 | *1.85* |
| Tucker's Imperial for Potatoes | ...... | ...... | † [34] 2.13 | 1.53 | 1.80 | *1.23* | ...... | ...... | 9.01 | 8.64 | 8.71 | *9.* | ...... | ...... | 2.02 | 2.47 | 2.47 | *1.85* |
| Tucker's Original Bay State Fertilizer | ...... | ...... | ...... | 2.17 | †1.99 | *2.06* | ...... | ...... | ...... | 9.19 | 8.17 | *9.* | ...... | ...... | ...... | 2.24 | 2.29 | *2.* |
| Tucker's Special Potato Fertilizer | ...... | † [35] 2.65 | ...... | 2.22 | †2.19 | *2.06* | ...... | 7.52 | ...... | 6.96 | 7.37 | *8.* | ...... | 5.55 | ...... | 5.83 | 5.39 | *6.* |
| Williams & Clark's Am. A. B. Superphos. | †2.82 | †2.77 | 2.55 | 2.57 | †2.43 | *2.47* | 9.19 | 9.67 | 10.17 | 10.36 | 9.32 | *9.* | 2.55 | 1.99 | 1.82 | 2.29 | 2.23 | *2.* |
| Williams & Clark's Am. Corn Phosphate | †2.28 | †2.30 | 2.36 | 2.13 | †2.28 | *2.06* | 8.85 | 8.21 | 9.35 | 9.80 | 8.24 | *9.* | 1.72 | 1.59 | 1.65 | 1.76 | 1.68 | *1.5* |
| Williams & Clark's Am. Potato Manure | 2.17 | †2.19 | 2.29 | 2.14 | 2.13 | *2.06* | 9.00 | 8.78 | 9.03 | 9.13 | 8.30 | *8.* | 3.17 | 3.19 | 3.39 | 3.29 | 3.42 | *3.* |
| Williams & Clark's Am. Potato Phosphate | †3.00 | †2.82 | 2.50 | ...... | 2.66 | *2.47* | 6.08 | 6.31 | †7.10 | ...... | 6.44 | *6.* | 5.35 | 5.74 | 5.51 | ...... | 5.47 | *5.* |
| Williams & Clark's High Grade Special | ...... | ...... | † [36] 3.47 | †3.27 | †3.23 | *3.3* | ...... | ...... | [36] 8.98 | 8.96 | 8.52 | *8.* | ...... | ...... | 7.08 | 6.83 | 7.90 | 7. |
| Williams & Clark's Prolific Crop Producer | ...... | ...... | ...... | 1.16 | 1.05 | *0.82* | ...... | ...... | ...... | 7.96 | 7.43 | *6.* | ...... | ...... | ...... | 1.34 | 1.18 | *1.* |
| Williams & Clark's Royal Bone Phosphate | 1.32 | 1.25 | 1.36 | 1.18 | 1.35 | *1.03* | 7.72 | 8.29 | 8.74 | 8.70 | 8.91 | 7. | 2.56 | 2.16 | 2.25 | 2.65 | 2.53 | *2.* |

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[34] Nitrogen guaranty, 1.

[35] Nitrogen guaranty, 2.4.

[36] Nitrogen guaranty, 3.7; available phosphoric acid guaranty, 7.

## VII. MISCELLANEOUS FERTILIZING MATERIAL.

### CRUDE STOCK

Analyses of and comments upon various kinds of raw materials sold in the state are grouped on the next three pages. The user of commercial fertilizers is urged to study them, to familiarize himself with the various materials, and, as has been aptly said by an agricultural writer, to think in terms of nitrogen, available phosphoric acid and potash rather than of phosphate and of guano.

### (*a.*) MATERIALS FURNISHING NITROGEN

NITRATE OF SODA, DRIED BLOOD, COTTONSEED MEAL

| Nitrate of Soda | | Dried Blood | | Cottonseed Meal | |
|---|---|---|---|---|---|
| Sampled at | Nitrogen | Sampled at | Nitrogen | Sampled at | Nitrogen |
| | % | | % | | % |
| Glen........ ......... | 15.39 | Bradford ......... | 10.60 | Highgate .. ... | 6.87 |
| Bradford ......... | 15.89 | Highgate .. ...... | 7.64 | Waitsfield..... | 6.98 |
| Highgate .. ...... | 15.33 | Jonesville ........ | 9.27 | St. Johnsbury | 7.45 |
| Jonesville ........ | 15.54 | Pomfret ........... | 9.60 | ................... | 7.29 |
| Woodstock ...... | 16.11 | Corinth ........... | 14.39 | St. Johnsbury | 7.21 |
| Burlington ...... | 15.99 | | | Burlington ... | 7.18 |
| Highgate .. ...... | 15.57 | | | Burlington ... | 6.96 |
| Corinth.. ......... | 15.61 | | | | |
| Averages ..... | 15.68 | ...................... | 9.98 | ................... | 7.13 |

Nitrate of soda cost this spring, delivered in Vermont, from $39 to $47.50 a ton; nitrogen ranged in price from 12.4 to 15.1 cents, averaging 13.2 cents.

Dried blood delivered cost, according to the grade of the goods, from $24 to $33, and ranged in price to the pound of nitrogen from 11.5 to 15.7 cents, averaging 14 cents.

Cottonseed meal cost delivered from $22 to $24 a ton. Allowing 4½ cents a pound for the phosphoric acid and potash which cottonseed meal contains (averaging phosphoric acid 3.00 per cent, potash 1.80 per cent), the nitrogen cost from 12.3 to 13.5 cents per pound and averaged 13 cents a pound.

Vermont farmers seldom think of cottonseed meal as a fertilizer, yet hundreds of thousands of tons are thus used yearly in the south and large quantities even in New England. It is undoubtedly better to feed it to stock in moderate quantities, enriching both ration and manure, thus getting two returns for one expenditure. But where more nitrogen is needed than the manure pile supplies, it is safe to say that at the prices ruling during the past few years, no cheaper source of readily available organic nitrogen has been offered in small quantities in our markets than in cottonseed meal. The schedule of trade values used by this as well as by other New England stations allows 14 cents a pound for organic nitrogen at the seaboard. It has cost this year on the average in cottonseed meal delivered in Vermont but 13 cents a pound. Nitrate of soda and cottonseed meal seem on the whole the most advisable materials to use as sources of nitrogen in home mixed goods this year.

### (*b.*) MATERIALS FURNISHING NITROGEN AND PHOSPHORIC ACID

BONE MEAL, TANKAGE, FISH SCRAP, ETC.

| Material | Sampled at | Mechanical analysis | | Chemical analysis | |
|---|---|---|---|---|---|
| | | Finer than 1–50 inch | Coarser than 1–50 inch | Nitrogen | Total Phosphoric Acid. |
| | | | | % | % |
| Tankage............ | Bradford ........ | 87 | 13 | 6.86 | 13.28 |
| Ground bone..... | West Burke ... | 86 | 14 | 2.66 | 20.54 |
| Ground bone..... | East Burke..... | 85 | 15 | 2.08 | 14.80 |
| Ground bone..... | Danville......... | 60 | 40 | 3.64 | 21.95 |
| Ground bone..... | Burlington ..... | 99 | 1 | 3.62 | 17.10 |
| Dry ground fish.. | Bradford ........ | 71 | 29 | 7.60 | 12.50 |

Two of the ground bone samples were extracted goods from which much of the nitrogen had been removed in glue manufacture. The poorer lots sold for but two dollars less a ton than did a pure ground bone which contained nearly twice as much nitrogen and half as much again of phosphoric acid. The better goods, however, were not ground quite as finely. Selling prices ranged from $28 to $30, and valuations from $16.54 to $23.71.

### (*c*) MATERIALS FURNISHING AVAILABLE PHOSPHORIC ACID

### ACID PHOSPHATE, ETC.

| Material | Sampled at | Phosphoric Acid. | | | | |
|---|---|---|---|---|---|---|
| | | Soluble | Reverted. | Insoluble | Total | Available |
| Acid Phosphate | Corinth | 11.11 | 1.97 | 0.48 | 13.56 | 13.08 |
| Keystone Phosphate | Corinth | 0.00 | 21.37 | 22.26 | 43.63 | 21.37 |
| Acid Phosphate | Bradford | 10.00 | 4.91 | 1.00 | 15.91 | 14.91 |
| Acid Phosphate | Hardwick | 3.47 | 9.56 | 4.89 | 17.92 | 13.03 |
| Acid Phosphate | Highgate | 10.46 | 2.32 | 0.75 | 13.53 | 12.78 |
| Acid Phosphate | Woodstock | 8.42 | 4.90 | 2.50 | 15.82 | 13.32 |
| Acid Phosphate | Burlington | 9.93 | 3.10 | 1.90 | 14.93 | 13.03 |
| Acid Phosphate | New Haven Mills | 3.96 | 6.10 | 5.25 | 15.31 | 10.06 |
| Average of seven acid phosphates | | 8.20 | 4.70 | 2.40 | 15.30 | 12.90 |

Acid phosphate (often called by the trade "dissolved bone," a misleading title) cost delivered in Vermont from $12.20 to $16 a ton, and ranged in price per pound of available phosphoric acid from 4.6 to 6.2 cents in price, averaging 5.6 cents. This is less than the cost of the same ingredients in dissolved bone-black.

### (*d*) MATERIALS FURNISHING POTASH

### POTASH SALTS.

| Material | Sampled at | Potash | Material | Sampled at | Potash |
|---|---|---|---|---|---|
| | | % | | | % |
| Muriate | Corinth | 50.08 | Muriate | Woodstock | 52.68 |
| " | Highgate | 47.56 | " | Hardwick | 50.48 |
| " | Glen | 52.20 | | | |
| " | Bradford | 53.12 | Sulphate | Woodstock | 50.28 |
| " | Burlington | 49.44 | Kainit | Randolph | 14.92 |
| " | Highgate | 52.16 | " | Hardwick | 12.88 |

Eight samples of muriate of potash varied in potash from 47.56 to 52.68 per cent, in cost from $40 to $45, potash costing from 4.1 to 4.4 cents a pound delivered in Vermont and averaging 4.3 cents. The potash in kainit cost nearly 6 cents. It is doubtful whether the other salts contained in kainit compensate for the extra price.

UNIV. OF MICH.
APR 30 1900

# UNIVERSITY OF VERMONT
# AND STATE AGRICULTURAL COLLEGE

# VERMONT AGRICULTURAL
# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 72

SEPTEMBER, 1899

## Certain Potato Diseases and Their Remedies.

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II. Certain Insects Injurious to Potato Foliage—Page 6.
III. Diseases of Non-Parasitic Origin—Page 9.
IV. Diseases Due to Parasitic Fungi—Page 13.
V. Fungicides for Potatoes—Page 25.
VI. Dates, Methods and Cost of Spraying Potatoes—Page 29.

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Director's office, chemical and horticultural laboratories are at the Experiment Station building, at the head of Main Street; botanical and entomological laboratories are at Williams Science Hall, University Place.

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# BULLETIN NO. 72

## CERTAIN POTATO DISEASES AND THEIR REMEDIES

AS INVESTIGATED AT THE VERMONT EXPERIMENT STATION, 1889–1899 [1]

BY L. R. JONES.

## I. INTRODUCTION.

*The inception of the work.* The cause of and remedies for potato blight were the first problems assigned to the botanical department of this experiment station after its establishment in 1889. It was at that time supposed that all cases of premature death of the foliage and of decay of the tubers were directly or indirectly due to the fungus, *Phytophthora infestans*. During this same season, 1889, practically all of the potato plants in the state were killed in early August by the blight, and the small crop of tubers was further reduced by the rot. The average yield of potatoes in Vermont under favorable circumstances when free from disease is 200 to 300 bushels an acre, yet the census returns, 1883–1893, show an average of but 97 bushels an acre. This surprisingly small yield is explained by most cultivators as due to the blight and rot. Clearly the problems were worthy of investigation.

*Some of the results of the investigations.* The results have been most satisfactory, but the problems have proved much more complicated than was at first supposed.

It has been learned that while the fungus *Phytophthora infestans* causes great loss in certain seasons, there is another fungus, *Alternaria Solani*, even more commonly present in potato fields and frequently occasioning serious blighting of the foliage. In many cases, however, the so-called "blight" is not a fungus disease at all, but is of a purely physiological or non-parasitic origin, or is very directly associated with obscure insect injuries.

It is necessary to understand the causes in order to apply remedies intelligently. Fortunately the matter of remedies has been greatly simplified by two developments; first, the bordeaux mixture has proved an almost perfect preventive, not only of both of the fungus diseases, but also of certain of the insect troubles; and, second, the arsenical poisons (paris green, etc.) can be added[2] to the bordeaux mixture, thus forming a combined fungicide and insecticide of unequalled effectiveness. Moreover the use of this mixture serves in a remarkable and somewhat unexplained manner to lessen the development of the non-parasitic diseases.

Experimental use has been made of this remedy each season for eight years. Uniformly large gains have resulted, as are shown by the following table, which fairly represents the conditions upon later potatoes. Early ones have not shown quite so large an increase.

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[1] Prepared for the use of the Committee of the Association of American Agricultural Colleges and Experiment Stations at the Paris Exposition, being a resumé of previous publications from this station.

[2] This combination was first used by Weed. See Ohio Exp. Sta., Bul. 141 (1889.)

GAINS FROM USE OF BORDEAUX MIXTURE UPON LATE POTATOES

| Variety | Planted | Sprayed | Yield per acre | |
|---|---|---|---|---|
| | | | where sprayed | where not sprayed |
| White star | May —, 1891 | Aug. 26, Sept. 8 | 313 bu. | 248 bu. |
| " " | May 20, 1892 | July 30, Aug. 13, 25 | 291 " | 99 " |
| " " | May 20, 1893 | Aug. 1, 16, 29 | 338 " | 114 " |
| " " | Apr. 26, 1894 | June 16, July 17, Aug. 30 | 323 " | 251 " |
| " " | May 20, 1895 | July 25, Aug. 13, 31 | 389 " | 219 " |
| Polaris | May 15, 1896 | Aug. 7, 21. | 325 " | 257 " |
| " | June 1, 1897 | July 27, Aug. 17, 28 | 151 " | 80 " |
| White star | May 10, 1898 | July 21, Aug. 10 | 238 " | 112 " |
| | | Average for past eight years | 296 | 173 |

These gains in some seasons (e. g. 1892 and 1893) have been chiefly due to the action of the remedy in checking the development of the fungus, *Phytophthora infestans;* there has usually been some gain in checking the development of the fungus, *Alternaria Solani;* and in all cases the mixture has done much good as a deterrent of insects.

The great gains arising from the use of this mixture can best be understood, however, in connection with the following statements regarding the development of the potato tuber.

*The development of the potato tuber.* The cultivated potato plant has been highly bred and rapidly developed into a thing quite different from the original wild plant of the Mexican and South American plateaus. There it tended to reproduce itself largely by seeds, as well as by small tubers. Man has bred and selected it to reproduce by tubers alone, so that now seed bearing plants are rarely seen. The plants do, however, continue to produce blossoms freely, and it is just as these are fading that the beginning of tuber formation occurs. The ancestral tendency of the plant at this time is to develop seeds and then die. The tendency acquired by cultivation is to throw all the reserve strength into tuber formation. These reproductive processes cause a severe drain upon its vital energies, and the fortnight immediately following the blossoming period is therefore a peculiarly critical time for the plant, during which its very life hangs in the balance. If once carried safely past this critical period and well started toward tuber formation, with foliage healthy and abundant, its life may be prolonged for many weeks, indeed almost indefinitely; but if during this critical period the plant is seriously weakened by insects, fungi, or other agencies, so as to start it upon a decline, it seldom fully recovers. More usually under such conditions it succumbs to the enervating process of tuber formation and soon dies. The practical importance of this condition is apparent when it is understood that the entire crop of salable tubers is formed after this critical period is past, and that the full success of the crop depends upon retaining the healthy foliage for from one to three months after the blossoming period.

The following figures, showing the time and rate of development of the potato tuber, were secured at this station by digging successive plots at intervals of ten days, beginning at the close of the blossoming season, the plants being preserved in healthy condition by spraying:

YIELD OF TUBERS AT DIFFERENT DATES. WHITE STAR POTATOES, PLANTED MAY 20.

| Date of digging | Total yield per acre | Yield of marketable size | Average size of tubers |
|---|---|---|---|
| Aug. 2 | 58 bu | 30 bu | 1.6 ounces. |
| " 12 | 115 " | 75 " | 2 " |
| " 22 | 230 " | 163 " | 3.7 " |
| Sept. 1 | 304 " | 234 " | 4.4 " |
| " 12 | 356 " | 303 " | 5.2 " |
| " 22 | 379 " | 353 " | 5.7 " |

In the majority of potato fields in this section the plants are all dead by the last week of August, yet in the case cited above, which fairly represents average conditions, fully one-half of the marketable crop was formed after that date. The importance of maintaining the perfect health of the potato foliage during the last few weeks of its possible development is much underestimated. It is because of its great usefulness in so preserving the health of the foliage that the remarkable gains from the use of bordeaux mixture have been secured.

As already suggested, this efficacy of bordeaux mixture is attributable not only to its value as a fungicide, but also to its peculiar action as a deterrent against certain insects, and, likewise, to the fact that aside from its effect upon these parasites, it excites a more vigorous development of the potato foliage.

A brief account will now be given of the various insect injuries and fungus and other diseases [1] which are the cause of the blighting of potato foliage and rotting of the tubers, together with a discussion of the most successful remedial measures. In all cases, unless otherwise stated, these statements will be based primarily upon the work at the Vermont experiment station.

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[1] The following accounts include a discussion of all of the more important parasitic (fungus and bacterial) diseases of potatoes which are known to occur in the United States with two notable exceptions. These are:

(1.) The brown rot, a bacterial disease (Bacillus Solanacearum Smith), which is very destructive in the southeastern United States, but has not been observed north of southern New York. See U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 12 (1896.)

(2.) The potato scab, caused by the fungus Oospora Scabies Thaxter. Common and destructive throughout the United States and Canada. See Conn. Agr. Exp. Sta., Rpt. 14 (1890), p. 81.

## II. CERTAIN INSECTS INJURIOUS TO POTATO FOLIAGE.

The principal insect injuries to potato foliage in the northeastern United States are wrought by the following species: The Colorado potato beetle, *Doryphora decemlineata*, the flea-beetle, *Crepidodera cucumeris* and the grasshoppers, *Melanoplus sp.*

*The Colorado potato beetle.* These insects are especially active during June and early July before the plants come into blossom. They are destroyed by arsenical poisons (paris green, etc.) The insects are so numerous and omnipresent that some damage is practically unavoidable, but since their attacks largely precede the critical period in the development of the potato (see page 4), the plant recovers rapidly and the damage to the crop is small, providing timely use is made of the arsenites. Halsted[1] has found that the bordeaux mixture alone may more effectively protect plants against this beetle than does the poisoning with paris green. This is of course attributable to its action as a deterrent and not as a poison. The bordeaux-paris green mixture is certainly more effective than is paris green alone.

*Flea beetle.* These insects frequently cause more loss to the potato crop than do the potato beetles. This is largely because their attacks are most severe at or soon after the critical period in the development of the potato (July 20–Aug. 10 in Vermont). When badly eaten at this time, especially if the weather is dry, the plant never recovers. Arsenical poisons alone do not afford adequate protection. Fortunately, however, the combination of arsenites with bordeaux mixture does serve to keep off these pests. The following records[3] serve to show this fact.

1. Flea-beetle × 5.

THE NUMBER OF FLEA-BEETLE PUNCTURES FOUND IN FIFTY LEAFLETS FROM EACH OF TWELVE ADJACENT ROWS IN AN EXPERIMENTAL FIELD, 1893

| | | No. of punctures |
|---|---|---|
| Row 1. | Sprayed with very weak bordeaux mixture | 1794 |
| " 2. | " " " " " " and soap | 1071 |
| " 3. | Not sprayed (check) | 2511 |
| " 4. | Sprayed with strong bordeaux mixture | 1194 |
| " 5. | " " " " " and soap | 1090 |
| " 6. | " " weak " " | 1295 |
| " 7. | " " " " " and soap | 901 |
| " 8. | Not sprayed (check) | 2287 |
| " 9. | Sprayed with ammoniacal copper carbonate | 1587 |
| " 10. | " " " " " and soap | 1491 |
| " 11. | " " modified eau celeste | 1376 |
| " 12. | " " " " " and soap | 1052 |

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[1] N. J. Exp. Sta., Rpt. 16 (1895), p. 323.

[2] Stewart has called attention to the fact that the grubs of the flea-beetle infest the tubers, rootstocks and roots of potatoes, thereby causing considerable damage, including the trouble known as "pimply potatoes." See N. Y. State Exp. Sta., Bul. 113 (1896.)

[3] For composition of mixtures used in this series see p. 25.

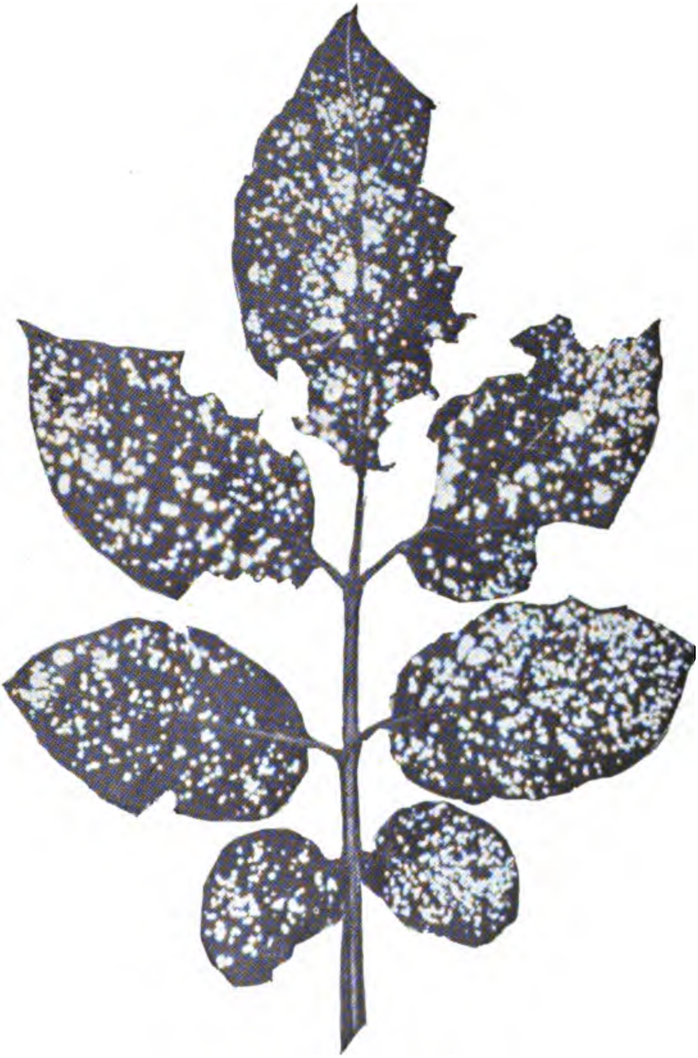


Figure 2. POTATO LEAF BADLY EATEN BY FLEA-BEETLES.

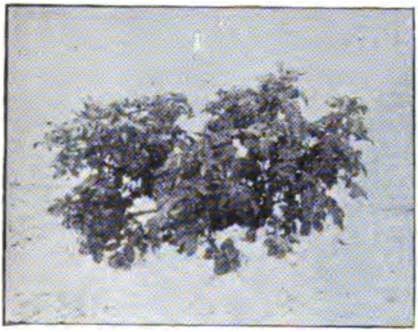


Figure 3. Single hill from field shown below, where sprayed with bordeaux mixture.

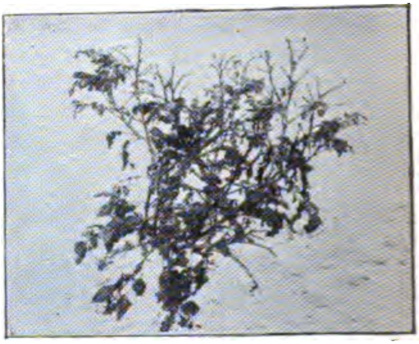
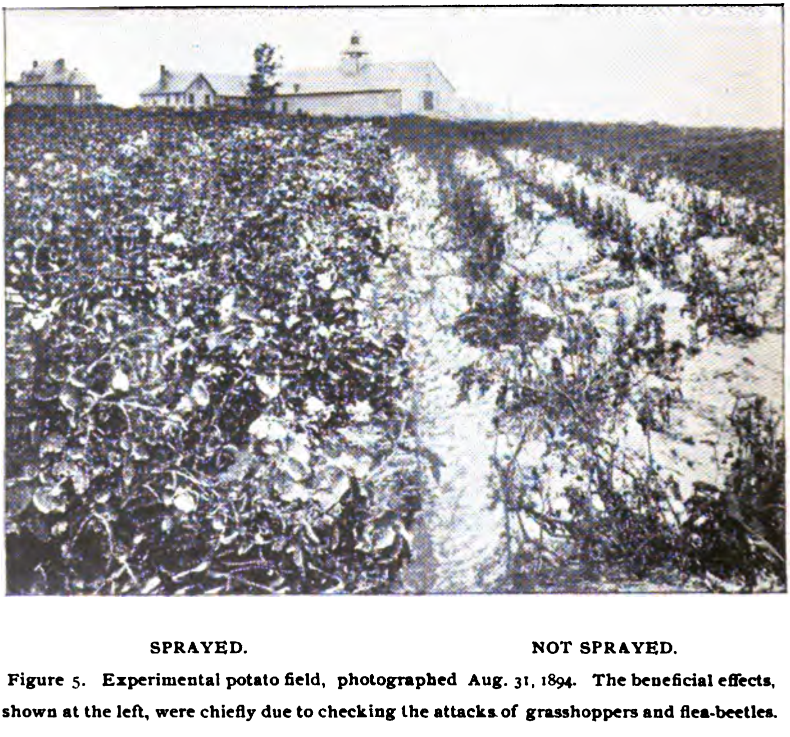


Figure 4. Single hill, not sprayed. The upper leaves cut off by grasshoppers.

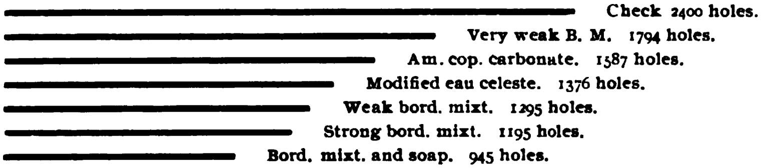


SPRAYED. NOT SPRAYED.

Figure 5. Experimental potato field, photographed Aug. 31, 1894. The beneficial effects, shown at the left, were chiefly due to checking the attacks of grasshoppers and flea-beetles.

These results clearly show that all these fungicides materially checked the ravages of the flea beetle, and that the addition of soap considerably increased their values in this respect.

The relative damages from the flea beetles where these mixtures were used may be expressed graphically as follows,



These results were obtained in 1893. Our experience since that date has shown that the protection from the bordeaux mixture alone is sufficient in practice, and we have discontinued the addition of the soap, which was found to be both expensive and troublesome.

*Grasshoppers.* Grasshoppers do much more damage during some seasons and in some localities than in others. The most serious injury done by them arises not from the eating of the leaf tissues, but from severing the petioles of the leaflets. Their invasion of the potato fields occurs in August, following the removal of grass from adjacent hay-fields. The bordeaux-arsenite mixture has proved an almost perfect deterrent against these insects also, whereas the arsenite alone has been ineffective. The benefits of spraying are shown in figures 3-5.

## III. DISEASES OF NON-PARASITIC ORIGIN.

### ARSENICAL POISONING.

It is necessary to make several applications of arsenical poisons to the potato plant during June and July in order to give protection against the potato beetle. The commercial preparations used, paris green, london purple, etc., are largely insoluble. A small per cent of soluble arsenious acid is always present however, and it is this which injures the potato foliage. This poison rarely penetrates the uninjured epidermis to do harm, but serious damage often results when it comes in contact with mutilated tissues, such as insect injuries, rents in the leaf, etc. The tissues die and blacken for some distance about such points, the resulting spots often resembling those caused by the fungus *Alternaria Solani.* In both cases if the death is slow the epidermis of the dying area is thrown into a series of concentric folds or wrinkles, giving a "target-board" marking to the spot.

*Remedy.* The full benefits from arsenical poisons can be obtained with lighter applications of arsenites than usually are made and such as will cause little or no injury (e. g. 1 pound in 100 to 200 gallons water or 0.12 to 0.06 per cent.) The slight remaining danger is eliminated when lime is added to the arsenite,[1] or when, as is preferable, the arsenite is applied in bordeaux mixture. In such cases the soluble arsenious acid is made insoluble by the lime and so rendered harmless.

## TIP-BURN AND SUN-SCALD.

*Tip-burn.* The disease we term "tip-burn" is characterized by the death of the potato leaves at their tips and margins, which portions dry, blacken and roll up or break off. The appearance of the diseased leaves is well illustrated in fig. 6. This trouble occurs quite commonly throughout the northeastern United States during the dry hot weather of midsummer. In its earlier stages the dead tissues are often quite free from invasion by fungi, and even in the advanced stages the fungi present upon the dead tissues at the tips or margins of the leaves are chiefly saprophytes.

There may be and frequently are early blight spots upon the leaves suffering from tip-burn, especially when the two diseases reach their advanced stages in the latter part of the season. As will be explained later, the early blight fungus is quick to establish itself upon the weakened portions of the leaves, hence, if it is present on the plants suffering from tip-burn, it often attacks the weakening tips of the leaves and so hastens their destruction. Moreover the early blight fungus is capable of living as a saprophyte upon the dead tissues of potato leaves and doubtless often appears in this role first upon these dead margins, but once thoroughly established it invades the green tissues adjoining. The saprophytic fungi almost invariably found upon these dead tissues are species of *Cladosporium* and of *Alternaria*. The detached spores of this saprophytic alternaria resemble so closely those of the *Alternaria Solani*, however, that we were considerably puzzled by them until we secured them in pure cultures. They were then clearly distinguishable by their appearance and mode of growth[2]. The saprophytic species proved to be *Alternaria fasciculata* (C. & E.) Jones & Grout[3], (see figure 11). In artificial inoculations made by placing spores from these cultures upon potato leaves we have been unable to get this *Alternaria fasciculata* to penetrate living potato leaves, whereas,

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[1] In preparing this lime mixture, place the paris green, or other arsenite, together with about an equal weight of fresh stone lime in a pail of hot water, mix them thoroughly as the lime slacks and allow the mixture to stand a couple of hours before applying. One pound of paris green prepared in this way, added to 100 gallons of water, is strong enough to destroy the potato beetles. During the latter part of the season the paris green may be added directly to the bordeaux mixture in the same proportion.

[2] See Vt. Exp. Sta., Rpt. 9 (1895), p. 51; Torr. Bot. Club, Bul. 24 (1897), p. 257.

[3] This is Alternaria Solani Sorauer, in part, see further discussion, p. 24.

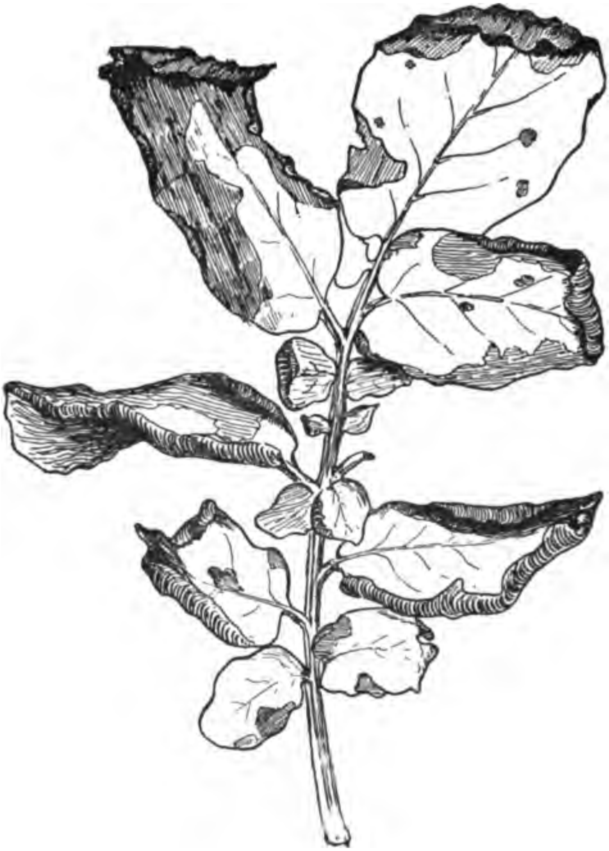

Figure 6. TIP-BURN OF THE POTATO LEAF.

when the *Alternaria Solani* spores were placed upon similar leaves the characteristic early blight spots appeared in a few days.

Tip-burn is not caused by the attacks of parasitic fungi. It is rather attributable to the unfavorable conditions surrounding the plant, especially to the dry hot weather, with insufficient water supply.[1] It is aggravated by any other conditions which tend to lower the general vigor of the plant, such as insufficient food supply, and attacks of insects and of the early blight fungus. This difficulty has not been observed to any serious degree upon plants until after they pass the blossoming period and naturally begin to weaken.

As the older leaves weaken, especially the lower leaves of the plants, the tissues of the interior of the leaf sometimes develop dead spots surrounding flea beetle punctures or other injuries. These spots soon dry and show distinct rings and bear a general resemblance to the "ringed spots" caused by paris green and by the early blight fungus. They may occur, however, in the absence of both these causes. We believe Sturgis is right in attributing these spots to the effects of dry, hot weather, and we would therefore associate them with tip-burn rather than with the true early blight.

*Prevention.* Effort should be made to increase and sustain the general vigor of the plant by proper selection of varieties, preparation and cultivation of the soil, and protection against the attacks of insects and fungi. The only thing that can be done in addition is to irrigate in times of extreme drought. Irrigation of potatoes is rarely practiced in the eastern United States outside of small gardens. We have seen marked benefits from watering such garden plots. In the western states, notably in Colorado, immense crops of potatoes are raised upon irrigated land.

In the eastern states proper attention to the accumulation of a store of humus in the soil, by the more frequent growth of clover, etc., will do much to reduce injuries from tip-burn. Such preparation of the soil, with more frequent tillage during periods of drought and proper spraying with bordeaux mixture, will reduce this damage to a thing of little practical importance.

*Sun-scald.* A very similar trouble is that which is often termed sun-scald. This is more common in the southeastern United States, although cases of it have been observed in Vermont. Galloway well characterizes it as follows:[1]

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[1] Sturgis, Conn. Exp. Sta., Rpt. 18 (1894), p. 129, expresses the opinion that "extreme heat and dryness accentuated by lack of moisture in the soil may induce the death of tissues at a distance from the roots (the tips and edges of the leaflets)." Lodeman, Cornell Exp. Sta., Bul. 113(1896), p.258, describes what appears to be this disease as it occurs in his state and says that "potatoes grown upon dry soils, which are naturally warm and 'quick,' are more subject to the disease than those grown in moister places in the same field. * * * Water seems to be the one thing most needed."

"Long-continued cloudy and damp weather followed by several hot and bright days is very apt to result in the burning (scalding) of the foliage. This is especially the case on soils carrying a comparatively small percentage of moisture. When the weather is cloudy and damp the tissues of the potato become gorged with water and this has a tendency to weaken them. If the sun appears bright and hot when the leaves are in this condition, there is a rapid evaporation of the moisture stored up in their cells. The evaporation may be faster than the supply furnished by the roots, and if this continues for any length of time the weaker and more tender parts first collapse, then die, and finally turn brown and dry up." The ultimate appearance of the foliage is so similar to that described under tip-burn that it is possible to distinguish them only when the climatic conditions are known.

## IV. DISEASES DUE TO PARASITIC FUNGI.

### LATE BLIGHT OR MILDEW AND ROT. (*Phytophthora infestans* D. By.)

*Occurrence.* It was formerly thought that this fungus caused general and serious loss throughout the United States. The more critical observations which have been made at the various experiment stations and by the officials of the department of agriculture during the last ten years show that its destructive occurrence is confined to a limited area in the northeastern United States and Canada. The outbreaks south and west of this region are so occasional and local as not to enter into the practical problems of the cultivator.

*Prevention.* Trial of bordeaux mixture as a preventive was first made at the Vermont experiment station in 1889. The results were so gratifying as to lead to its advocacy as a practical remedy at that time. Experimental use has been made of this and other fungicides each year since and the conviction has deepened that bordeaux mixture, if intelligently used, is an almost perfect preventive of the dreaded potato blight. The essential things are that it be applied as a fine spray so as to cover the upper surface of the foliage before the fungus begins to spread, and that the spray be repeated often enough to renew this protective coating as it disappears from the action of the weather or growth of the plants. In the blight infested region this requires from two to three thorough applications during the season. The first of these should be made about July 25, the second in from ten days to three weeks. Whether the third is necessary or not as well as the date of its application will depend upon conditions of weather and disease development.

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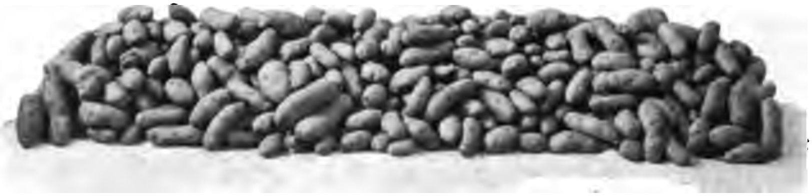
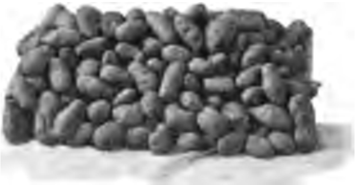
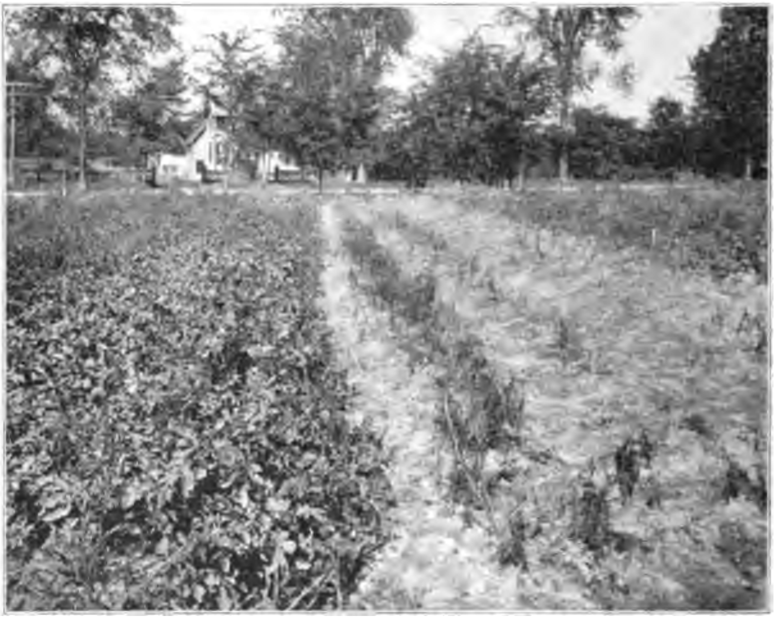
[1] Galloway, B. T., Potato Diseases and their Treatment. U. S. Dept. Agr., Farmers, Bul. 91 (1899), p. 10.



Total yield of marketable potatoes from two rows sprayed.



Total yield of marketable potatoes from two rows not sprayed.



SPRAYED. NOT SPRAYED.

Figure 7. From photograph of experiment station potato field, Sept. 10, 1892, showing results of three applications of bordeaux mixture in preventing phytophthora injuries.

The amount of gain as well as the completeness of the protection secured are well shown by the results of the seasons of 1892 and 1893, during each of which the disease was very destructive. The results may be summarized as follows[1]:

*Results of spraying, 1892.* A comparative test was made in 1892 of twelve different fungicides to determine their relative merits in checking the late blight of potatoes. The work was duplicated upon different soils and with several varieties of potatoes. All the plants were late enough to escape the early blight and remained healthy and vigorous until the warm, rainy weather of the middle of August. Phytophthora then began to spread rapidly on all the unsprayed plots. Each of the fungicides tested was of some value, but none of them equaled the bordeaux mixture.

The benefit from the use of the bordeaux mixture was striking. The leaves of the unsprayed plants were dead by the middle of August, while those sprayed remained green and vigorous until the last of September. The appearance of the field on September 10th is shown in figure 7. The increase in yield from this prolonged life of the vines and from checking the rot was great. The yields from the plots shown in the engraving were :

| | **Sound marketable tubers per acre** | **Rotten tubers of marketable size** |
|---|---|---|
| Plots sprayed with bordeaux mixture.. | 324 bu. | 3 bu. |
| Adjoining plots not sprayed............... | 100 " | 23 " |

*Gain from use of bordeaux mixture, 224 bu. an acre = 224 % increase.*

*Results of spraying, 1893.* Both early and late varieties were planted in 1893, so that the development of the early blight as well as of the late blight might be watched and remedies tested. The late blight fungus was very destructive during the latter part of the season and led to much rot following the blight. Owing to the long continued and late development of the blight this rot was not so fully checked by spraying as it was during 1892.

| | **Sound marketable tubers per acre** | **Rotten tubers per acre** |
|---|---|---|
| Plots sprayed with bordeaux mixture...... | 375 bu. | 24 bu. |
| Adjoining plots not so sprayed......... ..... | 121 " | 150 " |

*Gain from the use of bordeaux mixture 254 bu. an acre = 210% increase.*

The comparative merits of various forms and strengths of bordeaux mixture, as well as of fungicides other than this mixture, are discussed in detail on page 25.

*Selection of seed as a preventive of phytophthora.* The conviction has grown in our minds in connection with the experiments that it is possible by means of *thorough spraying coupled with careful selection of seed* to exterminate phytophthora from any locality. We believe, indeed, that we have at this experiment station practically succeeded in doing this, but the complete demonstration of this fact by field culture may require some seasons longer.

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[1] For detailed accounts see Vt. Exp. Sta., Rpts. 6 (1892), pp. 57-66; 7 (1893), pp 41-53.

All the evidence indicates that the fungus is propagated only in the tuber. It is always possible to secure seed tubers from fields which have suffered little or not at all from the blight. If need be seed potatoes can be grown on elevated dry ridges and in dry sandy soil, when if they are thoroughly sprayed they can be kept free from the invasions of phytophthora under any ordinary circumstances. If this is done the greatest source of danger from the fungus will be removed.

### THE EARLY BLIGHT OR LEAF SPOT DISEASE. (*Alternaria Solani*, [E. & M.] Jones & Grout.)

*Characters and occurrence.* This is a more recently observed fungus disease of the potato and allied plants. In its attacks upon potatoes in the northern United States and Canada the spots begin to appear in July upon early potatoes and become increasingly common and destructive from that time until the plants die. This fungus does not ordinarily attack healthy, vigorous potato leaves however, hence the destructive spread of the disease does not begin until the plants have passed their stage of greatest vigor. This occurs soon after the blossoming period and when the plants are forming tubers rapidly, the inroads made by the early blight at this time often being very disastrous. This fungus does not attack the tubers directly, however, and never causes them to rot.

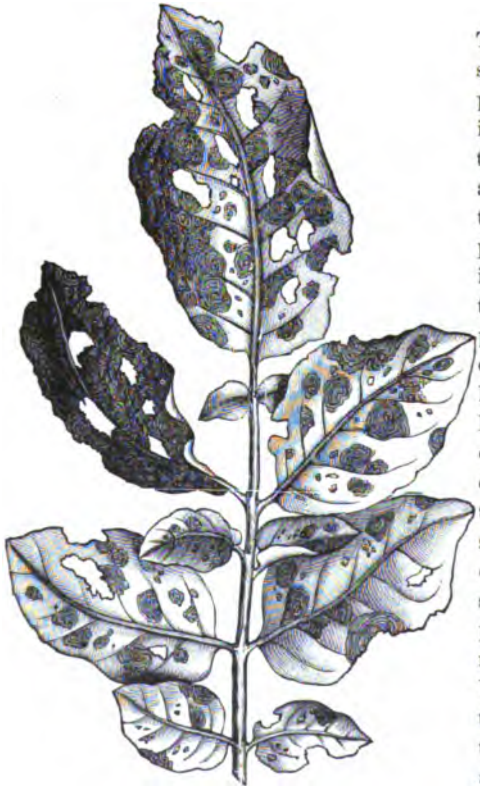

Figure 8. Characteristic appearance of leaf in advanced stages of early blight. (After Galloway, U. S. Dept. Agr., Farmers' Bul. 15.)

The appearance of the leaves affected by this early blight is shown in figures 8 and 9. Figure 9 represents the early stage upon a rather young potato leaf. It will be observed that the spots are scattered quite irregularly over this leaf, yet the preference which the fungus has for places where the leaf is weakened in any way is shown by the position of several of the dead spots bordering upon or surrounding flea-beetle punctures. It should be noted, however, that the majority of these spots have no such relation to flea-beetle punctures or other mutilations and, further, that a majority of the flea-beetle holes have no spots bordering upon them. This illustrates the fact that the spots and holes have no necessary relation, since the fungus can penetrate the unmutilated tissue of a green leaf; also that the mutilation of the green leaf by flea-beetle or other agencies does not of itself cause the spots. As the spots slowly enlarge the dead tissues dry and thus shrinking are thrown into peculiar folds which form broken and very irregular concentric rings, which have been described as the "target-board" markings. These markings are as yet scarcely developed in the leaf shown in figure 9. Their form in the older spots is well represented in figure 8. This leaf also well illustrates the fact that in an old leaf the spots develop most destructively upon the parts having the lowest vitality, i. e.: at the tips and margins, or about mutilations, though they are by no means confined to these. As the spots enlarge they may meet and fuse together, involving large areas of the leaf, this enlargement again being most rapid in the weaker tissues. As the tissues dry the tips and margins often roll up, giving the older leaves something of the same appearance as those killed by tip-burn as described earlier. This has lead to a common confusion of the two troubles, the more so since the two disorders very frequently appear on the same leaf and are mutually aggravating.

*Remedies.* The complication of this disease with tip-burn and insect attacks, together with its frequent association with phytophthora in the latter part of the season have made difficult the determination of the comparative value of different remedial measures. Thorough spraying with bordeaux mixture is the most important measure. The date and number of applications must vary with circumstances but in our experience these should be the same as those already outlined for controlling phytophthora. Attention should also be given to improved cultural condition as suggested for the prevention of tip-burn, that the plants may be insured adequate supplies of moisture and food, especially during the latter part of their development.

### LABORATORY STUDIES UPON ALTERNARIA SOLANI.

Inasmuch as this fungus has recently appeared in Europe and threatens to become there of a considerable economic interest the following abstract is given of our studies upon it.

This fungus was first described by Ellis in *American Naturalist* in 1882[1] as occurring on potato leaves. Its relation to the now familiar early blight of potatoes was first recorded by Galloway [1] in 1891, and later in that year and in 1892 by various other observers in this country.[2]

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[1] Am. Nat. 16, (1882), p. 1003.

The opinion was generally expressed or implied by these observers that the fungus was the cause of the disease, although its association with insect injuries or an otherwise weakened condition of the leaf was constantly noted.

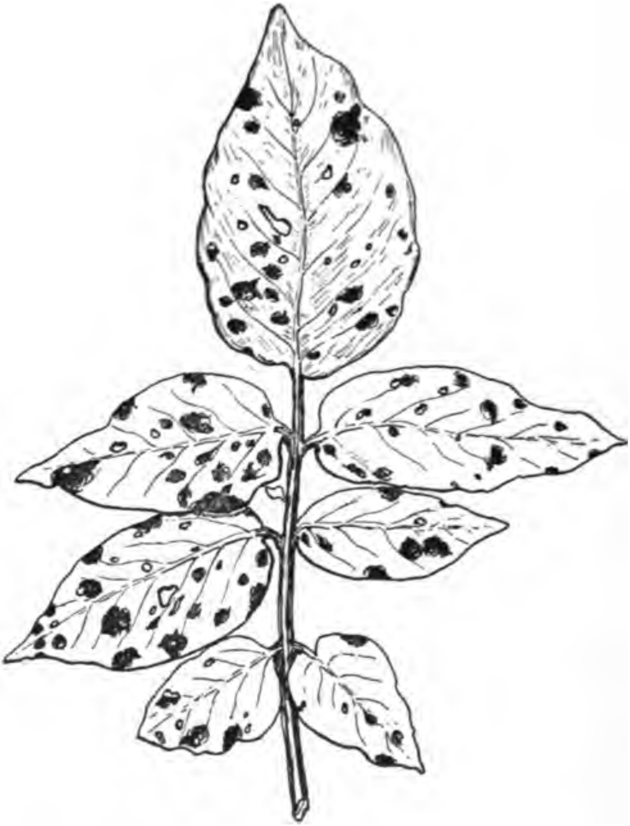

Figure 9. Early stages of alternaria attacks (early blight) on a young potato leaf.

Chester stated in 1891 that he made successful infections of the leaves of tomato plants with the fungus[3] and Galloway[4] states that spores sown on healthy potato leaves produce the characteristic spots in eight or ten days.

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[1] Galloway in correspondence and in Garden and Field, Adelaide, Australia, (June, 1891).

[2] Humphrey in Mass. Exp. Sta., Rpt. 9 (1891), p. 226. Chester in Del. Exp. Sta., Rpt. 4, (1891), p. 58.

See also notes and discussion in Vt. Exp. Sta., Rpts. 5 (1891), p. 131; 6 (1892), p. 66.

[3] Loc. cit., p. 59.

[4] Agricultural Science, 7 (1893), p. 377.

Sturgis after reviewing this evidence in 1894[1] considers that Chester's inoculations, from the manner in which they were made, were inconclusive, and that evidence was still lacking to prove that the fungus was the direct and only cause of the disease. He concludes that "it seems possible that the early blight of potatoes may be due to the physiological effects of extreme heat and dryness acting upon leaf tissues at a distance from the roots and already injured by predatory insects, and that tissues so injured are liable to the attacks of certain fungi, which may enhance the injury." He therefore considered this fungus to be either a "partial parasite or a wound parasite."

Our own previous observations had led us to consider the fungus an active disease-inducing agent, but we recognized the need of more study along the lines suggested by Sturgis, and undertook in 1895 to obtain answers to the following questions :

1. With what forms of potato-leaf injuries is the fungus *Alternaria Solani* associated ?

2. Is it possible to produce diseased spots by inoculating healthy living potato leaves, growing under normal conditions, with spores taken from a pure culture of this fungus ?

In obtaining evidence regarding the first point hundreds of potato leaves were collected and examined from our own fields, a large amount of material collected at Burlington and other points in Vermont during previous years was re-examined, and, finally, examination was made of considerable material sent from the various experiment stations of the northern and eastern states. The results were conclusive. In all cases where the characteristic early blight spots occurred in the interior of the leaves, the diseased tissues were found to be invaded by this fungus, and usually by no other in the earlier stages of the disease. In the earlier part of the season (in July and early August) many of these spots plainly centred about flea beetle punctures or similar injuries, allowing of no doubt that the fungus gained entrance to the interior tissues at such points of injury, but more spots could be found on nearly all diseased leaves which showed no such relation to insect or other injuries. The leaves which began to spot earliest in the leason were the lower, and, hence, older and more shaded leaves of the plants. There was also an evident preference of the fungus for the weaker leaves, and for the weaker portions of the leaves, i. e., tips and marginal areas. As the season advanced the disease increased and the spots were no longer confined to the lower or older leaves and in a great majority of cases showed no relation to insect injuries, the small green leaves at the summit of the plant becoming peppered with spots almost as soon as expanded. These facts are in accord with our observations in 1892, that "insect punctures or other injuries to the leaf offer a favorable starting point for this fungus," and that "this disease does little damage (in Vermont) until after the plants blossom and pass their stage of greatest vigor."[1] The fungus is, however, decidedly more than a wound parasite, since it attacks unmutilated portions of living leaves. As it occurs in Vermont it is well described by a term employed by Sorauer of Berlin, as one of the class of "Schwache-parasiten," or "weakling parasites," i. e., parasites upon weakly organisms.

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[1] Conn. (State) Exp. Sta., Rpt. 18 (1894), p. 132.

The economic importance of the fungus is rather enhanced than lessened by this fact, since the potato plant is ordinarily in just such a weakened condition throughout the latter portion of its possible life, and it has been shown (see page 5) that this is the time of the greatest importance in the crop production.

In order to secure answers to the second question proposed, viz : as to the ability of the fungus to gain an entrance into living potato leaves, pure cultures were started from single spores of the alternaria. Such cultures produce spores very sparingly in their earlier stages, but later, under favorable conditions often sporulate freely.

When the surface of such a spore-bearing culture was rinsed with water an abundance of free spores was obtained and at a favorable temperature these began to germinate almost immediately. (See figure 11, 1.) Inoculations were usually made in our investigations by applying some water thus charged with fresh spores upon the potato leaf by means of a recently sterilized camel's hair brush. Inoculations were repeatedly secured in this way, by our botanical assistant, Mr. C. C. Tracy, in which diseased spots infested with the fungus appeared within three to five days after the application of the spores upon leaves which were vigorous at the beginning of the experiment.[2] In most of this work we were obliged to use potato plants grown in the green house and they were confined for a short time after the inoculation under a bell jar. It is true that a plant thus grown in the winter in the moist atmosphere of the greenhouse is probably less able to resist the invasion of fungi than is a similar plant grown out of doors during the summer months, yet the conditions are not altogether unlike those existing out of doors during a period of rainy weather. While the results of these inoculations made by Mr. Tracy during the winter months had, therefore, answered the second question in a fairly satisfactory manner, it seemed desirable, for the reasons given, to repeat the work with plants grown out of doors. This was done with the assistance of Mr. A. J. Grout during the summer of 1896. The details of a single inoculation experiment will suffice.

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[1] Vt. Exp. Sta., Rpt. 6 (1892), p. 67.

[2] The most serious obstacle in the process of securing inoculations lay in the difficulty of preventing the spores strewn upon the surfaces of the leaves from drying. This was overcome in some of the experiments by placing dishes of steaming water under the bell jar, while covering the outside of the jar with a towel wet with cold water, in others a flask of water was kept gently boiling, and the steam thus generated was conducted to the interior of the jar through a glass tube. A very convenient scheme used by Mr. Grout was to draw to a fine hair-like point a glass tube of rather large bore. By filling this tube with water and suspending it at an angle with the minute orifice of the capillary end over the leaf, a slow dripping of water resulted which was regulated at pleasure so as to replace the water upon the inoculated leaf as rapidly as it evaporated.

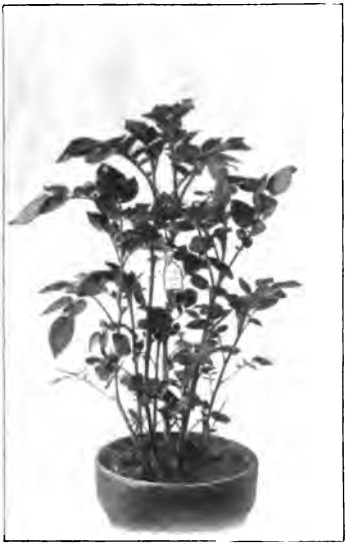

Figure 10. Potato plant inoculated with Alternaria Solani.

In order to force the growth faster and handle the plants more conveniently potatoes were grown in pots, starting them in the greenhouse and later setting the pots in the soil out of doors. The plant in question was about one month old, and in full vigor (See figure 10). The spores were applied in water with a camel's hair brush, as already described, to one of the younger leaves (label attached, figure 10) situated near the top of the plant on the northeast side. This was done at 7 P. M. There was a fairly copious dew that night. As the air was warm and dry the next morning a large bell jar was placed over the plant and remained there until evening, to prevent the thorough drying of the surface of the leaves. Water was dropped from a pipette upon the inoculated leaf at intervals during this day and also the next.

On the sixth day after the application of the spores small black spots were visible on the leaflets. These gradually increased in size and numbers, having in all ways the characteristic appearance of the typical early blight spots caused by alternaria, including the "target board" markings.

On the ninth day one of the smaller leaflets, which had a well developed spot, was removed and examined. Upon the upper surface of the leaf about the middle of the spot two large alternaria spores were found, which had germinated freely, and several of the germ tubes were traced into the leaf tissues. Moreover, the dead tissue was thoroughly permeated with a fungus mycelium agreeing in all its characters with the mycelium of the alternaria. A small portion of the tissue from the diseased spot was examined to determine that there were no spores upon its surface and then placed in a culture dish of agar. A luxuriant growth of mycelium soon began to radiate from it, which proved to be *Alternaria Solani*. Another leaflet was removed on the fourteenth day after the inoculation. Examination of this leaf showed the presence of sporophores bearing spores of the alternaria protruding from the under surface of the leaf as well as the upper, thus completing a chain of evidence which must satisfy any existing doubts as to the parasitic habit of this fungus.

Attention is further directed to figure 11, 2, which shows the vigorous germination of the alternaria spores and the mode of entrance of the germ tubes into the leaf tissues, both through the breathing pores and by direct penetration of the outer walls of the epidermal cells. These drawings were made from a potato leaf inoculated five days previously. Once within the leaf the fungus apparently finds little difficulty in making its way through and between the cell walls in all directions until the tissue is thoroughly permeated by it. The production of spores is usually delayed until the death of the host tissues and is rarely very abundant even then. The spores are produced on sporophores which either push out through the breathing pores or break directly through the outer walls of the epidermal cells, being found in greatest numbers on the upper surface.

Many spots infested by the fungus bear few or no spores, however, and rarely are many found. This paucity of spores is somewhat puzzling in view of the very vigorous development of the mycelium. The spore production does not cease with the death of the leaf tissues, however; this event appears rather to mark its active beginning. The most abundant sporulation is always found on the dead tissues of the older spots. Moreover, this mycelium retains its life for a considerable period of time, certainly for a year or more, as shown by placing in culture media bits of old potato leaves infested with the fungus when a vigorous growth of the mycelium has followed. Similar bits of mycelium from culture dishes, eight months old, dry and hard, when placed in fresh culture dishes, resumed growth at once. It is quite probable, therefore, that the mycelium passes the winter in a resting condition in the dead tissues of potato plants and produces spores again the following season. The spores likewise retain their vitality for a considerable period. Those a year old germinate quite vigorously, although we have not as yet succeeded in inducing those two years old to grow. There seems little need then to the fungus of any special resting stage or other form of spore in order successfully to propagate itself, nor have we seen indications of any such condition either on potato leaves or in culture dishes.

### EXPLANATION OF FIGURE 11.

1. Single spore of *Alternaria Solani*, showing germ tubes from three cells (*a*, etc.) From culture on prune-agar. Magnified 280 diameters.

2. Two spores of *Alternaria Solani*, germinating and penetrating surface of living potato leaf. *d*, Normal stoma of potato leaf; *b*, *b*, similar

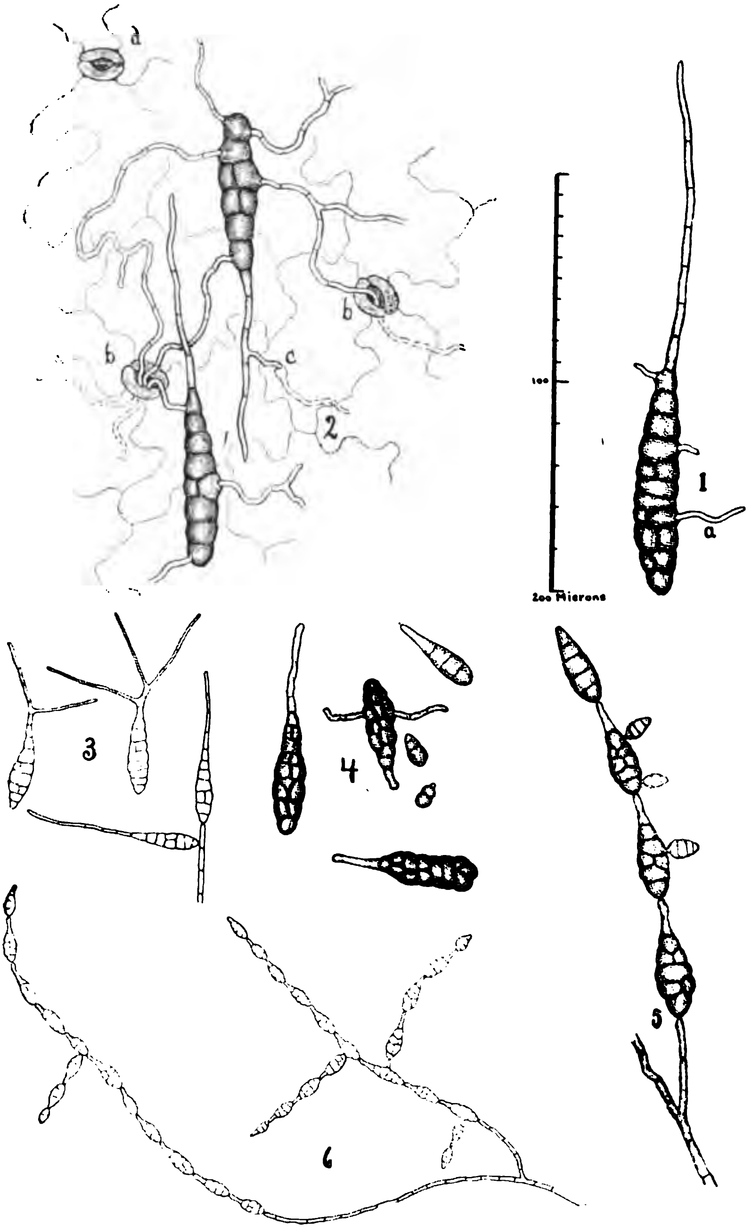

Figure 11. POTATO LEAF FUNGI.

stomata through which the germ tubes have entered the interior of the leaf; *c*, germ tube penetrating outer wall of an epidermal cell. Spores from culture on prune-agar, examined and drawn five days after placing on potato leaf. Magnified 280 diameters.

3. Spores of *Alternaria Solani*, showing peculiar forms. Magnified 140 diameters.

4. Spores of the saprophytic *Alternaria fasciculata* occurring on potato leaves, three mature and three immature. Central one germinating. Magnified 280 diameters.

5. Fruiting branch of *Alternaria fasciculata* from culture on prune-agar. Magnified 280 diameters.

6. Similar branches of *Alternaria fasciculata*. Magnified 140 diameters.

In one of these agar cultures which was sporulating freely, Mr. Grout observed frequent cases where two spores were clearly joined in pairs, as shown in the accompanying figures. The occurrence of these spores in such a culture leaves no doubt of their identity; moreover their measurements, as well as other characters, correspond with the typical spore of *Macrosporium Solani*, E. & M., and do not in any way resemble the spores of the *Alternaria fasciculata* previously described. They serve to settle beyond all doubt the fact that *Macrosporium Solani*, must be classed as an Alternaria and known as *Alternaria Solani*.

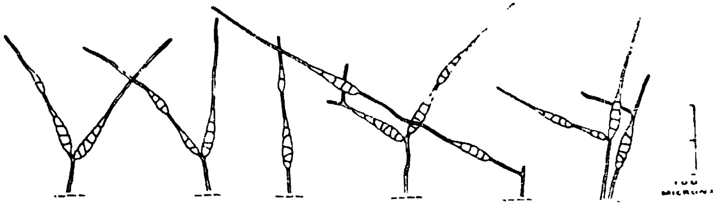

**Fig. 12. Alternaria Solani, grown on prune-agar, showing spores borne in catenulate pairs**

While these experiments were in progress and before their publication, an article by Dr. Paul Sorauer appeared,[1] in which he reported the destructive occurence of this fungus in Germany, and also gave the results of studies in which he grew the fungus in culture and also made successful inoculations from these cultures upon living potato leaves.

In this article Dr. Sorauer describes and illustrates an *Alternaria* form of the fungus, and therefore changes the name from *Macrosporium Solani* E. & M., to *Alternaria Solani* Sorauer. A careful comparison of his results with our own cultures convinced us that Sorauer had in his culture dishes the same *two* species of fungi which we had discovered upon American plants, viz., *Alternaria fasciculata* and *Alternaria Solani*, and the alternaria spores as described and figured by him were all the *Alternaria fasciculata*.

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[1] Zeitschrift für Planzenkrankheiten, 6, 1, 1896.

We advised him of this fact, and he courteously sent us specimens of the potato leaves upon which his examinations were made. As anticipated, both of the alternarias were there found, and Sorauer has since in correspondence affirmed the correctness of our observations and conclusions. The only published observation of the alternaria form of the parasitic species is therefore that made by ourselves[1] and the authority for the name becomes *Alternaria Solani* (E. & M.) Jones & Grout.

## V. FUNGICIDES FOR POTATOES.

The great gain obtained by spraying potatoes with the bordeaux mixture have already been stated. This mixture or some substitute for it ought therefore to be used in regularly spraying all potato fields. There are two serious hindrances to the more general use of this fungicide, however; first, the fact that it is insoluble and hence somewhat more troublesome to apply than it would be if soluble; and, second, that to obtain the most effective mixture it must be freshly prepared as used. Trials of many other fungicides have been made at this station in the hope of finding a substitute not open to these objections.

### OTHER FUNGICIDES COMPARED WITH BORDEAUX MIXTURE.

These trials have included the following in addition to the various forms of bordeaux mixture which will be discussed by themselves later. The approximate proportion of each ingredient is given to 100 parts of water:

Copper-soda solution (copper sulphate 2 parts, sal soda 3 parts.)

Verdigris solution (verdigris 0.6 to 1.2 parts.)

Ammoniacal copper carbonate (copper carbonate 0.1 part, strongest aqua ammonia 0.8 parts.)

Copper and ammonium carbonate (copper carbonate 0.25 parts, ammonium carbonate 0.5 parts.)

Modified eau celeste (copper sulphate 1.1 parts, sal soda 1.4 parts, strongest aqua ammonia 0.9 parts.)

Copper carbonate in suspension (copper carbonate 0.5 parts.)

Glue mixture (copper sulphate 0.33 parts, sal soda 0.4 parts, liquid glue 0.3 parts.)

Copper chlorid (0.2 parts.)

Sulphosteatite (applied as dry powder.)

Copper sulphate (0.1 to 1. part.)

Soap as an addition to various of these.

Molasses as an addition to various of these.

---

[1] Statements in a letter made by K. Sengoka, Sapporo, Japan, lead us to believe that he saw the Alternaria form of the spores earlier than did we, but so far as we know he did not publish these observations.

The trials of some of the more promising of these have been extended over several years, but all have proved decidedly inferior to bordeaux mixture. The only one which has at all approached this mixture in the protection it afforded is the modified eau celeste. This is, however, considerably more expensive than is the bordeaux mixture, is liable to injure the foliage unless used with care, and it has in no case equaled the mixture as a fungicide. This latter fact is illustrated by the following figures:

| | Yield of tubers in bushels | |
|---|---|---|
| | Sound | Rotten |
| Three applications bordeaux mixture in 1892... | 324 | 2 |
| " " modified eau celeste........... | 291 | 2 |
| Three applications bordeaux mixture in 1893... | 406 | 23 |
| " " modified eau celeste........... | 305 | 87 |

TRIALS OF VARIOUS FORMS OF BORDEAUX MIXTURE.

A large number of experiments with the bordeaux mixture of varying strengths and prepared by divers methods have been made during these ten years. These have included comparative trials of the mixture in varying degrees of concentration and made with different proportions of lime; the freshly made mixture has been compared with that which has been allowed to stand some time after preparation; trials have been made of mixtures in which the two chemicals were brought into combination in varying degrees of concentration; a prominent place has also been given to commercial bordeaux mixtures and to the dry forms or bordeaux powders. Without entering into wearisome details, the more important conclusions may be summarized as follows:

An excess of lime beyond that necessary to neutralize the copper sulphate does not appreciably increase the value of the mixture. For practical purposes, however, we recommend the use of a certain excess of lime, viz., 2 parts of lime to 3 parts of copper sulphate.

The more concentrated the mixture the more complete has been the protection afforded by it, but a medium strength (1½ pounds or 2% copper sulphate, + 1 pound or 1.2% lime, + 10 gallons water) has proved best suited to practical field operations. This is best when made by quickly uniting the diluted solutions of the two ingredients (copper sulphate and lime), and it deteriorates upon long standing. Mixtures made by using concentrated solutions of either or both ingredients, mixtures which have stood for some time so that the precipitate has settled, and concentrated commercial mixtures are all inferior in mechanical properties, tend to settle more quickly, are impossible of uniform application and do not adhere to the foliage as well as do freshly and properly made mixtures.

Bordeaux powders, either applied dry or as carried in water, have given decidedly inferior protection to the foliage as compared with the usual or wet forms of the mixture.

The basis for these conclusions lies to a considerable degree in observations made upon the condition of the foliage during the various seasons when they were undergoing trial. It is partly a matter of the yields of tubers obtained from trial plots. The following figures will serve as examples of the latter and are fairly representative of others to which we cannot give space :

| In 1895, three applications : | Yield in bushels per acre | |
|---|---|---|
| | Sound | Rotten |
| Standard bordeaux mixture | 389 | 67 |
| Old mixture, after 2-6 weeks standing | 322 | 112 |
| Bordeaux powder, applied dry | 235 | 182 |
| Check, no fungicide | 219 | 168 |

| In 1896, three applications : | Yield bushel per acre |
|---|---|
| Mixture containing 2 parts lime to 3 parts copper sulphate | 109 |
| “ “ 1 “ “ “ 3 “ “ “ | 111 |

(This difference is within the limits of soil variation.)

| In 1898, two applications : | |
|---|---|
| Standard bordeaux mixture, freshly made | 186 |
| Commercial mixture, bought in concentrated form and diluted | 159 |

Laboratory studies with bordeaux mixtures prepared in various ways have also shown striking differences, especially in the rate at which the precipitate settles. (Fig. 13.) Thus when a mixture, properly and freshly made from diluted ingredients, quickly united, was placed in a glass cylinder, it was found that upon standing one hour the precipitate had settled so as to leave but 4% of the column of liquid clear ; whereas a cylinder containing mixture prepared by uniting concentrated solutions of the ingredients settled in one hour so as to leave 52% of the column of liquid clear. A mixture properly made and allowed to stand for two weeks, when thoroughly agitated and allowed again to settle, showed 56% of the column of liquid clear at the end of one hour. It is believed that the greater value of the properly made mixture is attributable to its superior mechanical composition. Swingle[1] has shown that in freshly and properly made bordeaux mixture the precipitate consists largely of precipitation membranes. These are often in the form of small cells, of which the membranes are very thin, and to this condition is attributed the bulkiness of the precipitate and its slowness in settling. Concentrated solutions tend to form thick and diffi-

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[1] U. S. Dept. Agr., Div. Veg. Phys. & Path., Bul. 9 (1896.)

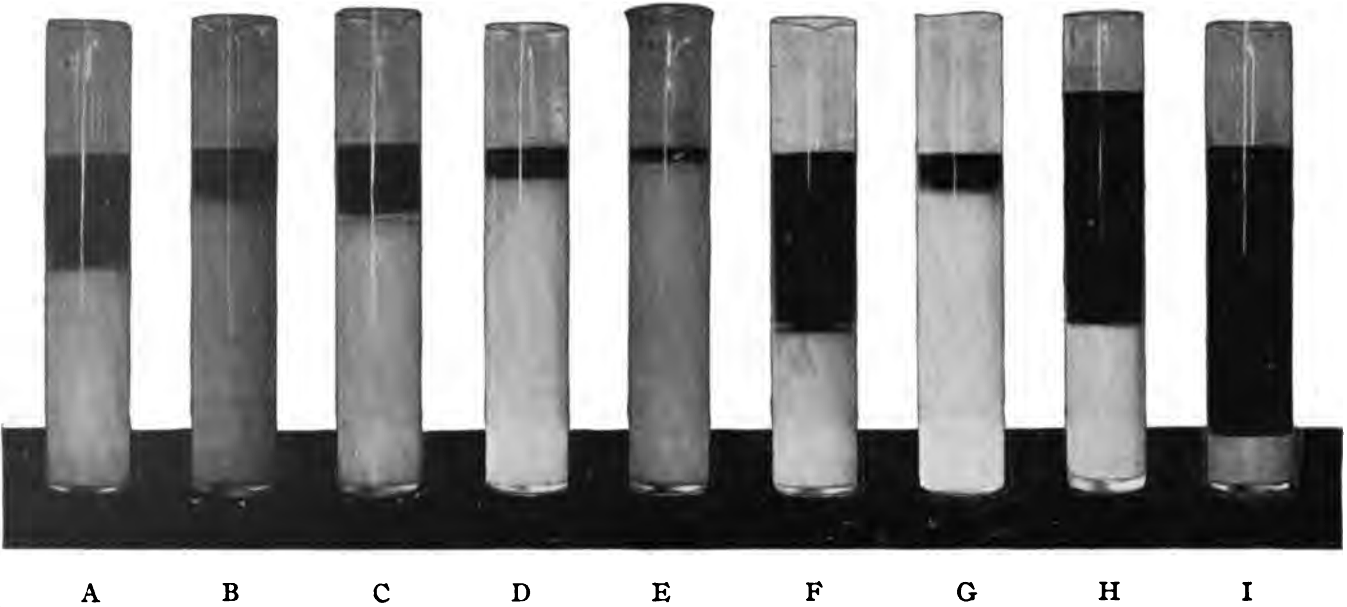


Figure 13. Glass cylinders showing relative rapidity of settling of the precipitate in bordeaux mixture made in various ways. Each cylinder stood one hour after making before being photographed. The dark portion in each jar was clear water (colored with ink so as to show distinctly); the lighter portion below was the precipitate.

A. Mixture made by pouring dilute lime into dilute sulphate slowly.
B. Mixture made by pouring dilute sulphate into dilute lime slowly.
C. Mixture made properly (as E), but using hot lime milk.
D. Mixture made as in E, but less thoroughly stirred.
E. Properly made bordeaux mixture, i. e. from cold dilute solutions, quickly united and thoroughly stirred,
F. Made same as E, but using concentrated solutions.
G. Properly made mixture, one day old.
H. Old or "stock" bordeaux mixture, made two weeks before.
I. "Bordeaux powder" mixed with water,

cultly permeable membranes and more closed cells which serve to delay the reaction. After a few days the precipitate becomes less bulky and consists largely of crystals instead of precipitation membranes.

## VI. DATES, METHODS AND COST OF SPRAYING POTATOES.

### DATE AND NUMBER OF APPLICATIONS.

Our conclusions as a result of nine years' observation are that the date and number of applications necessary to the best results cannot be foretold with certainty, as they vary from season to season even in the same locality, and must vary considerably under different climatic and cultural conditions. The following directions cover the case as nearly as may be for the northeastern United States :

It is presumed that the plants will be kept free from the potato beetle in the earlier stages of their development by the proper use of arsenites. The first application of the bordeaux-arsenite mixture should be made during or just after the blossoming period. This means about July 1 to August 1, in most cases. A second application should follow in about two weeks after the first. Whether a third application be made, and its date if made, must depend upon conditions of weather, insects and disease. Unless phytopthora is present and persistent, two applications will usually give adequate protection.

### METHODS OF APPLYING BORDEAUX MIXTURE.

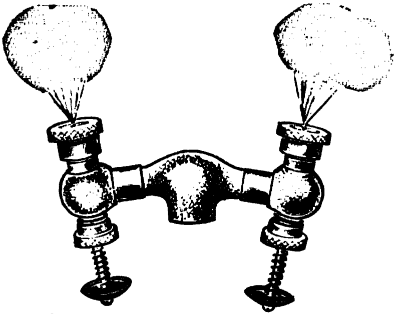


Figure 14. Double Vermorel Nozzle.

The satisfactory and economical application of the mixture upon the plants has proved a serious and practical difficulty. It cannot be done without the use of a pump capable of forcing the mixture through a proper spray nozzle. The vermorel nozzle, especially in the double (Fig. 14) or triple forms, gives the best spray and we prefer it for use in most cases. With the special cart sprayer (illustrated in Figs. 16 and 17) we use the calla nozzle. This is cheaper and simpler in construction and throws a more liberal spray, although not quite so fine as that of the vermorel.

There are five styles of pump from which to choose.

*The bucket pump* (cost $2 to $8). This is the cheapest spraying outfit obtainable and can be arranged to do excellent work, but is suitable only for small gardens.

*The knapsack pump* (cost $10 to $15). This is very useful and satisfactory for small plots and experimental purposes, but cannot be recommended where there is over one acre to be sprayed.

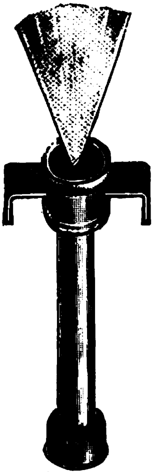


Figure 15.
Calla Nozzle.

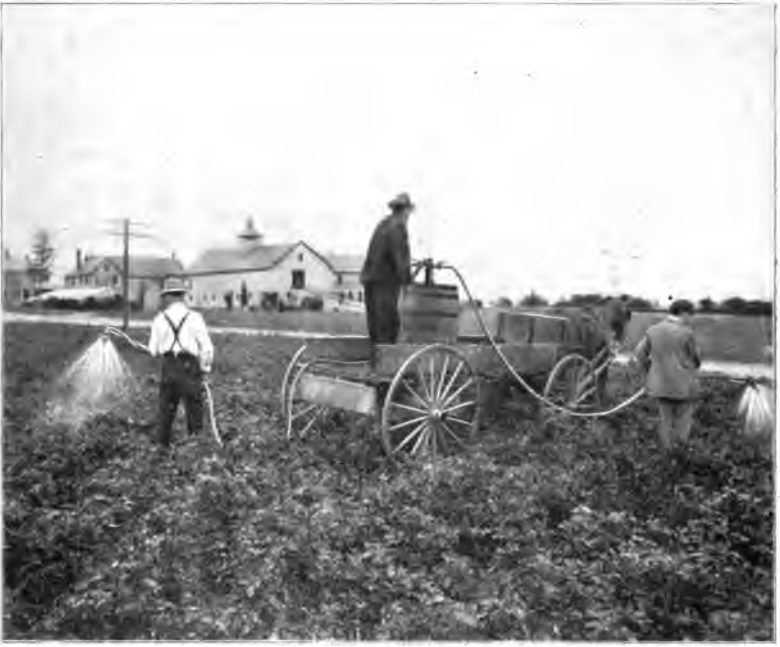
*The barrel pump* (cost $7 to $20). This is the most generally useful spraying apparatus yet devised. There are a large number of patterns on the market from which to choose. Such a pump is suited to spraying all other crops and fruit trees as well as potatoes. For work in the potato field there are two chief ways of using the barrel pump. The simplest consists in carrying the barrel through the field in a wagon while one or two persons walk and direct the spray nozzles (figure 16, above.) About six to eight rows may thus be covered at each time of crossing the field. If the potatoes are planted with reference to the operation, this method is entirely practical and satisfactory and represents the least possible outlay for apparatus.

A somewhat more elaborate and more expeditious method is shown in the lower half of figure 16. Here the same barrel-pump is mounted on a two-wheeled cart. The wheels are set six feet apart so as to straddle two rows while the horse walks between them. From two to four rows are sprayed at once by this apparatus and five to ten acres a day are easily covered by two men and one horse. In order to protect the vines a guard rod is placed in front of each wheel.

In large fields there is sometimes economy in the use of a geared pump, to be operated by horse-power. One of the most useful and economical types of these which has come under trial by us is shown in figure 17.

### COST OF SPRAYING POTATOES.

Bordeaux mixture, as we use it, costs about 0.8 cents a gallon. The aim is to apply from 150 to 200 gallons an acre, if two applications are made about 300 gallons are used, while three applications require about 500 gallons.



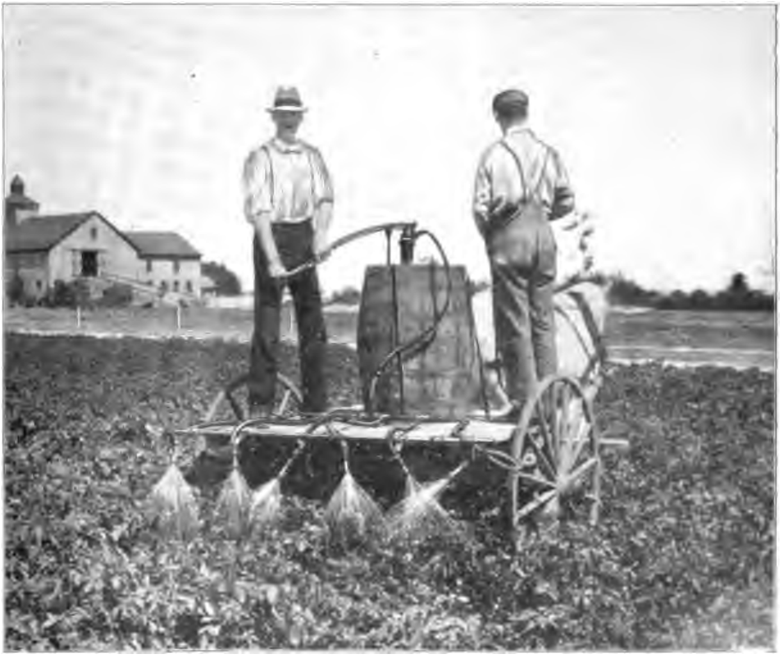


**Figure 16.** SPRAYING POTATOES AT THE VERMONT EXPERIMENT STATION.

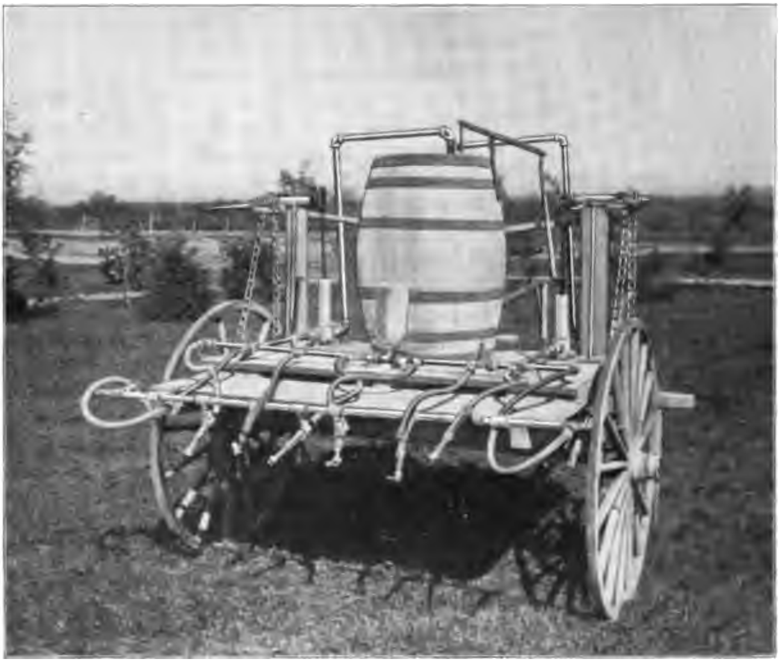


Figure 17. THE SPAULDING GEARED PUMP.

Two men with one horse will make and apply the mixture to five acres or more a day. Allowing $3.50 as their wages, this makes the cost 70 cents an acre each application. The cost of spraying properly during the summer then becomes as follows:

| | Two applications | Three applications |
|---|---|---|
| 300 to 500 gallons bordeaux mixture............. | $2.40 | $4.00 |
| Labor........................................................ | 1.40 | 2.10 |
| | $3.80 | $6.10 |

Inasmuch as the average increase from the use of the mixture upon our late potatoes during the past nine years has been 173 bushels an acre worth in the average 45 cents a bushel or $70.85, the financial gain from spraying is a large one.

UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

# EXPERIMENT STATION

BURLINGTON, VT.

## BULLETIN No. 73

OCTOBER, 1899

# The Trees of Vermont

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1899.

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# BULLETIN NO. 73: THE TREES OF VERMONT

By Anna M. Clark[1]

## INTRODUCTION

The following account aims to include the native and spontaneous trees of the state, together with brief mention of such others as are commonly cultivated. It is primarily addressed to readers who have little or no botanical training, but who may wish to learn the names of the trees and the characters by which they may be recognized as well as the main facts as to their occurrence and distribution in the state. It is believed that the drawings and simple keys accompanying the text will make this possible to all.

It has for some time been evident that such a publication would be widely welcomed. Vermont is a richly wooded area. Much of its wealth is directly or indirectly dependent upon its forests. Its growing fame as a region of summer homes is largely because of its attractive trees and forest areas. Moreover Vermont is peculiar in that the tree-covered areas are on the increase. It is well that this is so, for trees of the right kind are the most profitable crop that can be grown on a considerable portion of the hills and mountains of the state. The fact that this is being more emphatically taught by the board of agriculture and more commonly accepted as a guiding principle by the farmers of the state promises well for improved methods of farm and forest management during the present generation and for more valuable lands to be inherited by the next.

The intelligent fostering of this tree growth and the appreciation of its beauty as well as of its value is in a considerable measure dependent upon discriminating acquaintance with the different kinds of trees found in our forests. Few realize how many kinds there are. Within easy walking distance of the University at Burlington there occur, native, or spontaneous sixty kinds of trees. There is a greater variety of trees in the Champlain valley than in the interior of the state, yet the number of kinds to be found in any natural forest of limited area will be a pleasing revelation to one exploring it thoroughly.

It is especially to the children of Vermont and to the teachers of these children, either at home or in school, that it is hoped this publication will prove most interesting and most useful. A familiar acquaintance with the common trees and other plants of the neighborhood, together with their general characters and uses should be, and before long will be, an essential part of the education of every school boy and school girl.

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[1] Prepared under the direction of L. R. Jones. Edited by Clifton D. Howe and W. W. Eggleston.

Each should learn to recognize so many of the trees as occur commonly in his vicinity by leaf, fruit or bark. Nor will this be found very difficult if some study is given to the following pages.

The use of technical botanical terms has been avoided. It is realized that this has in some cases been attended by a loss of precision, but the larger gains must outweigh such minor losses. In all cases the drawings are intended to supplement the keys and descriptions. They were carefully made to scale, and the reduction from natural size is indicated by the accompanying fraction. Thus white pine × ½ indicates that the illustration shows the parts of this pine one-half natural size.

It is highly desirable that there should be greater uniformity in the popular use of plant names and especially of the names of trees. In order to bring this about Mr. G. B. Sudworth recently prepared a list of the preferred English names of the trees of the United States (U. S. Dept. Agr., Div. Forestry, Bul. 17). The usage of this article is in accord with Sudworth's recommendations and teachers are urged to follow it. Names, other than the preferred one, which may be commonly used in the state are included in parentheses. The Latin names are in general those of Sargent's Sylva of North America. Where these differ essentially from those of the botanical manuals in common use in the state the synonyms are added.

A practical difficulty was met in the deciding exactly what to include under the name tree. Nature makes no sharp distinction between trees and shrubs. Professor Sargent in the Sylva of North America considers as trees all woody plants which grow up from the ground with a single stem, excluding all such as habitually branch at the ground into a number of stems. It did not seem expedient to follow exactly these lines in the present publication. It may be useful, however, to add the names of the species native to Vermont which are included as trees by Professor Sargent in this Sylva, but which are not described in the following pages:

The common juniper *Juniperus communis*; four willows, *Salix discolor*, *S. rostrata*, *S. longifolia*, *S. lucida*; witch hazel, *Hamamelis Virginiana*; two sumachs, *Rhus typhina* and *R. copallina*; flowering dogwood, *Cornus florida*; mountain laurel, *Kalmia latifolia*; great rhododendron, *Rhododendron maximum*; sheepberry, *Viburnum lentago;* bear oak, *quercus ilicifolia*.

Much help was received in the preparation of this article from Sargent's Sylva of North America and from Emerson's Trees and Shrubs of Massachusetts. The first complete discussion of the occurrence and distribution of the trees in the state is found in Oakes' list of Vermont plants, published in

Thompson's Natural History of Vermont in 1842. A supplement to this was prepared by Professor Joseph Torrey in 1853. Professor Perkins again summarized the available information in his Flora of Vermont in 1887. The forest flora of the Connecticut valley was well discussed by Flint and Jesup in their Trees and Shrubs of New Hampshire, 1891. The information furnished in the above lists has been freely drawn upon.

C. G. Pringle very thoroughly explored the forest areas of the Champlain valley and of northern Vermont some twenty-five years ago. More recently this work has been continued by several botanists. It is not expedient here to mention the contributions of all, but credit must at least be given to those of President Ezra Brainerd regarding the flora of Addison county, of Dr. A. J. Grout regarding that of Windham county and of W. W. Eggleston regarding that of Rutland county. Mr. Eggleston has in addition made several trips through Bennington county and has also explored parts of the extensive forest areas of Essex county, thus adding much to the accuracy of the information regarding each of these regions. As a result it is believed that the general facts concerning the distribution of the trees of the state are fairly well understood and the attempt has been made to summarize these in the present list. There is still opportunity, however, for the botanical exploration of the forests, especially in the southern and the northeastern portions of the state and it is hoped that such imperfections as exist in this publication may be a stimulus in this direction.

The preparation of the drawings[1] and of the original manuscript was made by Miss Clark in connection with the botanical studies of her senior year at the University of Vermont (1897–8). The publication was delayed a year and a half and the rapid increase in knowledge of the state flora during this period made some revision necessary. Mr. Clifton D. Howe had immediate charge of this revision and of the final preparation of the matter for the press. Mr. W. W. Eggleston contributed much to the value of the publication by carefully revising and editing the statements concerning the occurrence and distribution of the species, especially as regards the Connecticut valley and southwestern Vermont. Professor F. A. Waugh furnished the statements about the cultivated plums and cherries and aided in other ways.

Thanks are due President Ezra Brainerd, Professor F. A. Balch, Rev. J. A. Bates, and other members of the Vermont botanical club who have kindly offered suggestions and read proofs.

L. R. JONES.

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[1] The drawing illustrating the balsam fir was made by Miss Ella K. Herrick.

## THE TREES OF VERMONT

(*) indicates introduced species now spontaneous; (†) occur only in cultivation.

PINE FAMILY
- Scotch pine (†)
- Austrian pine (†)
- White pine
- Red pine
- Pitch pine
- Jack pine
- Tamarack
- Black spruce
- Red spruce
- White spruce
- Norway spruce (†)
- Colorado blue spruce (†)
- Hemlock
- Balsam fir
- Arbor vitae
- Red juniper

WALNUT FAMILY
- Butternut
- Black walnut (†)
- Bitternut hickory
- Shellbark hickory
- Pignut hickory

WILLOW FAMILY
- Black willow
- White willow (*)
- Crack willow (*)
- American aspen
- Largetooth aspen
- Balm of gilead
- Cottonwood
- White poplar (*)
- Lombardy poplar (*)

BIRCH FAMILY
- White birch
- European white birch (†)
- Paper birch
- Yellow birch
- Sweet birch
- Hornbeam
- Blue beech

OAK FAMILY
- Beech
- Chestnut
- White oak
- Bur oak
- Chestnut oak
- Chinquapin oak
- Dwarf chinquapin oak
- Swamp white oak
- Red oak
- Scarlet oak
- Yellow oak

ELM FAMILY
- Slippery elm
- White elm
- Cork elm
- English (cork) elm (†)
- Scotch (weeping) elm (†)
- Hackberry

MULBERRY FAMILY
- Red mulberry
- White mulberry (*)

MAGNOLIA FAMILY
- Tulip tree

LAUREL FAMILY
- Sassafras

PLANETREE FAMILY
- Sycamore

ROSE FAMILY
- Apple (*)
- Pear (†)
- Crab apple (†)
- Mountain ash
- Elderleaf mountain ash
- European mountain ash (*)
- Serviceberry
- Scarlet hawthorns
- Longspine hawthorn
- Dotted hawthorn
- English hawthorn
- Canada plum
- Wild red cherry
- Choke cherry
- Black cherry
- Garden cherries (†)
- Garden plums (†)

PULSE FAMILY
- Locust (*)
- Honey locust (†)
- Coffeetree (†)

MAPLE FAMILY
- Mountain maple
- Striped maple
- Sugar maple
- Black maple
- Silver maple
- Red maple
- Norway maple (†)
- Boxelder
- Horse chestnut (†)
- Buckeyes (†)

BUCKTHORN FAMILY
- Buckthorn (*)

LINDEN FAMILY
- Basswood

DOGWOOD FAMILY
- Sour gum

OLIVE FAMILY
- Black ash
- White ash
- Red ash
- Green ash

BIGNONIA FAMILY
- Catalpas (†)

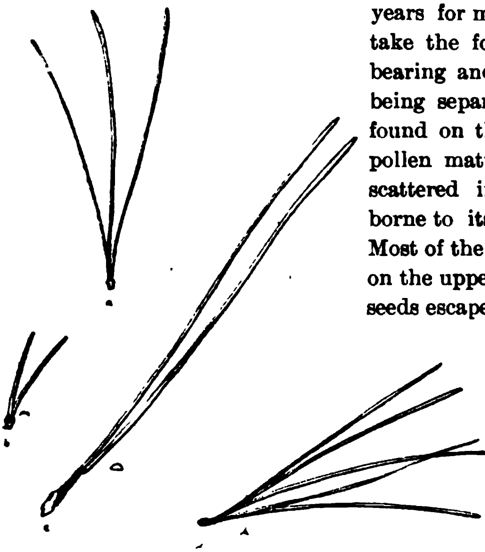
# PINE FAMILY

## THE PINES

The pines are the largest and most useful group of trees included in the great cone-bearing family. There are in the eastern United States nine different species, four of which are found in Vermont.

The pines, like the other trees of this family, produce their seeds in cones. The pines are peculiar, however, in that their cones require two years for maturing. The flowers also take the form of cones, the pollen-bearing and the seed-bearing clusters being separated, though both may be found on the same tree. The yellow pollen matures in May, when it is scattered in great abundance, to be borne to its destination by the wind. Most of the seed-bearing cones develop on the upper branches, and the nut-like seeds escape from them during the second autumn. The empty cones with opened scales may thereafter cling to the tree for some time or they may soon fall.

The leaves of all the evergreens cling to the branches several years. The leaves of the white pine, for example, drop when they are three or four years old. The arrangement of the leaves, or needles, in clusters of from 2 to 5, with the base of each cluster encased in a delicate sheath, offers a simple means of distinguishing the species.



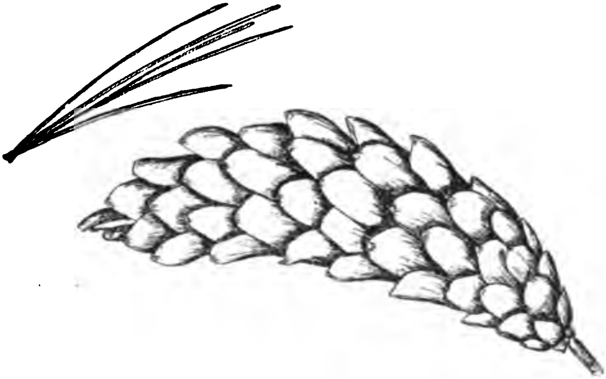
PINE LEAF CLUSTERS
a, Pitch; b, Gray; c, Red; d, White. All × ½

| | |
|---|---|
| Leaves 5 in each cluster | White Pine |
| Leaves 3 in each cluster | Pitch Pine |
| Leaves 2 in each cluster | |
| Leaves 4 to 6 inches long | Red Pine |
| Leaves 1 or 1½ inches long | Gray Pine |

*Introduced species.*—Two European pines are sometimes planted as ornamental trees in Vermont, the Austrian and the Scotch. The Scotch pine has leaves, 2 in a cluster, 2–4 inches long, flat and of a bluish-white hue. The Austrian pine has dark green, slender, rigid leaves, 2 in a cluster, 4–6 inches long.

### WHITE PINE. *Pinus Strobus* Linn.

The white pine, growing as it sometimes does to the immense height of two hundred feet or more, was one of the loftiest trees of the primeval New England forest. Lumbermen have removed most of the patriarchs and only the younger trees commonly remain. The species, though widely scattered in Vermont, occurs most abundantly in the Champlain and Connecticut valleys. The slender lustrous leaves are borne in close clusters and give a beauty and delicacy of foliage possessed by no other pine.



WHITE PINE
Cone and leaf cluster, ×½

The white pine takes its name from the color of its wood, which is soft, easily worked and is much used in all kinds of light woodwork. It is especially sought for inside house finishing. It is one of the most valuable and most rapidly growing timber trees in the state. The renewal of the pine forests should therefore be encouraged.

### RED PINE (NORWAY PINE). *Pinus resinosa* Ait.

The red pine is much less common in Vermont than the white pine. Scattered groups or small groves of it occur on the dry, rocky headlands of Lake Champlain and it may be found in similar soils in the river valleys throughout the state, although it is less frequent in the southern portions. Its heavier clusters of foliage with long leaves in pairs, serve to make its recognition easy. The cones are about two inches long at maturity.

The name red pine is appropriate both because of the pale red color of the heart-wood and the distinctly reddish cast of the bark. This species does not grow in Norway or elsewhere in Europe, and it is said that it received the name from the town of Norway, Maine. The name Norway pine has so little fitness as applied to this tree, and is so evidently misleading that its use is to be discouraged.

The Latin name suggests a resinous wood, but in fact it is less so than either of the other pines. The wood is light, hard, close grained, and is largely used for bridge and building timbers. The picturesqueness and individuality of the red pine commend it for wider use as an ornamental tree.

### PITCH PINE. *Pinus rigida* Mill.

The pitch pine is one of the more southern species, and is nearly at its northern limit in Vermont. The pines all flourish in light soils, but the pitch pine seems to thrive best in dry barren sand plains. In such locations it occurs abundantly in the northern parts of the Champlain valley, especially along the lower courses of the Winooski, Lamoille and Missisquoi rivers. It is also scattered along the Connecticut river valley.

In suitable places it forms dense groves of small trees, forty to sixty feet in height. The individual trees are sometimes picturesque but not graceful or otherwise very attractive in appearance. The branches of even the smaller trees mature numerous cones, which are long persistent. They are about two inches long and have the scales tipped with sharp recurved prickles, a character which may aid in the recognition of the species.

The wood is hard and resinous. Turpentine and tar were formerly obtained from it in New England. This resinous quality adds to its value as a fuel and for kindling wood. This is the principal use made of it at present.

### JACK PINE (GRAY OR SCRUB PINE). *Pinus divaricata* (Ait) Du Mort., *P. Banksiana* Lamb.

The gray pine is the smallest of the Vermont pines with sprawling habit and short stout leaves, giving the tree a bristly, stunted appearance. Its characteristic cones are pointed and curved toward the main axis of the stem, often partially encircling it. The gray pine is a northern species extending to the Arctic region, and the line of its southeastern limit passes through northern Vermont. It is one of the rarest of our trees, and but few specimens are known to occur in the state. Mr. Rowland E. Robinson of Ferrisburgh discovered a small grove of it in 1860. Scattered trees have since been found in Monkton, Starksboro and Fairfax. It probably occurs in other places in northern Vermont. The remaining trees should be sought out and spared because of their scientific interest.

### TAMARACK (HACMATACK, LARCH). *Larix laricina* (Du Roi), Koch., *L. Americana* Mich.

The tamarack is our only cone bearing tree which drops its leaves in the autumn. It is an attractive, conical tree, its graceful form and full clusters of slender, delicate leaves giving it well-marked individuality. Its deep red fleshy cones, which open in June, resemble flower clusters.

The wood is coarse grained but very strong and remarkably durable in contact with the soil. This fact gives it especial value for fence posts, telegraph and telephone poles and railway ties, much of the Vermont tamarack being used for these purposes. It is also used for dock planking.

The tamarack occurs commonly throughout the state. While it is usually found in

TAMARACK
Branchlet and cone, × ½

swamps it is said that it will grow more rapidly when transplanted to dry ground. This fact adds to its desirability for ornamental planting.

### THE SPRUCES.

Every Vermonter should know and appreciate the spruces. The mountain spruce and the sugar maple are the most characteristic trees of the state. The forests of North America contain seven species of spruce, three of which occur in Vermont.

The spruces are northern trees, and Vermont lies rather south of the belt of their most abundant growth in northeastern America. It is therefore our mountain sides and cool swamps which furnish conditions suitable for their best development.

The flowering cones are similar to those of the pine in general characters. The flowers appear in spring and the cones mature the following autumn, the seeds being shed during autumn or early winter.

Until recently botanists considered the two species, here described as the red and the black, to be simply varieties of one species, which then went under the common name of black spruce. In the lumber trade all three kinds are handled, without discrimination, as "spruce." As a matter of fact, the red spruce furnishes nearly all of the spruce lumber of this state. Spruce gum also comes chiefly from the red spruce, although it is formed by the other species.

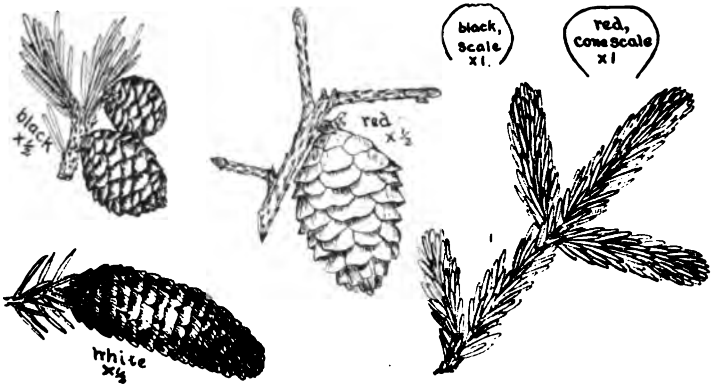
**Branchlets coated with minute hairs.**
  **Cones 1-1¼ inches long, clinging to the branches many years; scales of cone toothed at outer margins; leaves blue-green, paler underneath ........................................................ Black Spruce**
  **Cones 1-2 inches long, generally deciduous by the second summer, scales of cone with outer margins not toothed; leaves yellow-green. Red Spruce**
**Branchlets without hairs.**
  **Cones slender, 1-2½ inches long, leaves blue-green .................. White Spruce**

*Introduced species.*—The Norway spruce (*Picea excelsa*) is commonly cultivated in Vermont door yards, parks and cemeteries, and is superior to our native trees for such purposes. It is easily recognized by its more pendulous branches and very large slender cones, 5 to 7 inches long.

The Colorado blue spruce (*P. pungens*) is occasionally planted. This is characterized by its beautiful glaucous-blue foliage. The cones are three to five inches long.

### BLACK SPRUCE (SWAMP SPRUCE). *Picea Mariana* (Mill.) B. S. P., *P. nigra* Link.

This is the common spruce of the sphagnum (peat moss) swamps of the Champlain valley. It is also common in Essex county and probably occurs similarly in the other parts of the state, but the distribution is not well known because of its confusion until recently with the red spruce. A small, sterile, semiprostrate form occurs on the extreme summit of Mt.



SPRUCES

Branch, cones and cone-scales

Mansfield. (Eggleston.) Under the most favorable circumstances it is never a large tree, rarely reaching a diameter of one foot or a height of fifty feet. It is therefore a less valuable timber tree than either the red or the white spruce.

It has frequently been planted in Vermont as an ornamental tree. This is unfortunate, as the lower branches soon die, making it the least attractive of our native evergreens.

RED SPRUCE. *Picea rubens* Sargent, *P. nigra rubra* Engelm.

This is the common spruce of our mountain forests, the vast green expanse of which suggested the names of both mountain range and state. It is not commonly distinguished from the preceding species and both are known as black spruce. It attains a height of from seventy to one hundred feet and large logs may be three or more feet in diameter. When growing in open fields it often forms a conical head with the branches, especially of the younger trees, brushing the ground. In the more typical development, especially when in crowded forests, the lower branches soon perish, leaving the long naked trunks which the lumberman prizes.

The wood is light, soft and less durable than pine when exposed to the action of the weather. It is largely used for building timber and for clapboards and shingles. Owing to the fact that it imparts no flavor, spruce is used in the manufacture of butter tubs and boxes. Great quantities are consumed in the pulp mills. It is a tree of slow growth, large specimens in the primitive forests being often two hundred to three hundred years old.

The red spruce is frequently planted as an ornamental tree in Vermont, but its slower growth and less symmetrical form make it less desirable for this purpose than either the native white spruce or the Norway spruce.

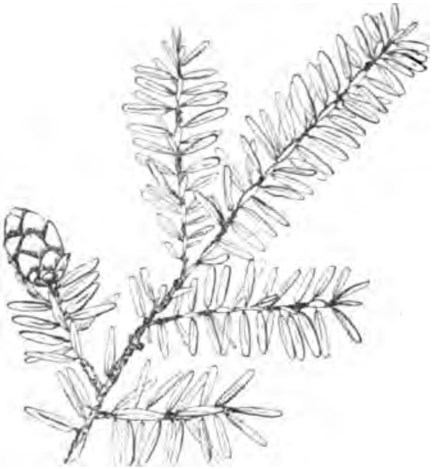
### WHITE SPRUCE. *Picea Canadensis* (Mill.) B. S. P., *P. alba* Link.

This is a northern tree, which extends from Canada into northern Vermont. It occurs along the Connecticut river to the Fifteen Mile Falls, (South Lunenburgh), and on the eastern arm of the Y of the Green mountains to the Montpelier and Wells River railroad, or perhaps a little farther south. It is common on some of the islands of Lake Champlain and is scattered through the forests of Essex county. The strong polecat odor of the young branches is characteristic and will aid in its recognition. Because of this odor it is often called skunk spruce. Lumbermen do not separate this from the other spruces and the tree is nearly equal in size to the red spruce.

The white spruce is one of the best of our native evergreens for ornamental planting, as it makes a rapid growth and with its persistent lower branches forms a perfect and symmetrical conical head which rivals the Norway spruce.

### HEMLOCK. *Tsuga Canadensis* (Linn) Carr.

The hemlock is one of the most graceful of our evergreen trees. It may be met with almost everywhere from the low river banks and swamps to the rocky hillsides and mountain forests. In distinguishing the hemlock from the spruce and balsam fir, one should notice the flat, petioled leaves arranged in a flattened spray with a row on the upper surface lying close to the stem. The small elliptical cones, scarcely more than three-fourths of an inch long, mature in the autumn and shed their seeds during the winter.



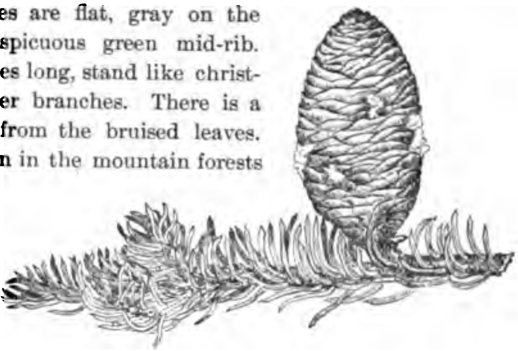
HEMLOCK, spray and cone, ×⅔

The wood of the hemlock is soft, brittle and shaky and it is used for cheaper building purposes and for shingles. It is, however, one of the most durable timbers for use under water. Hemlock bark is used for tanning and the bark from the tree is quite as valuable as the lumber.

### BALSAM FIR. *Abies balsamea* (Linn) Mill.

The balsam fir, more familiarly known as the fir tree or balsam, is a slender graceful tree when growing in open ground. It bears a general resemblance to the spruces, but is easily distinguished from them on close observation. The leaves are flat, gray on the under side, with a conspicuous green mid-rib. The erect cones, 2–4 inches long, stand like christmas candles on the upper branches. There is a characteristic fragrance from the bruised leaves. The balsam fir is common in the mountain forests throughout the state. It ascends to the highest summits of Mt. Mansfield and Camel's Hump but is there reduced to a low, scrubby growth.

The wood is light, soft and not durable. It makes a medium quality of shingles.

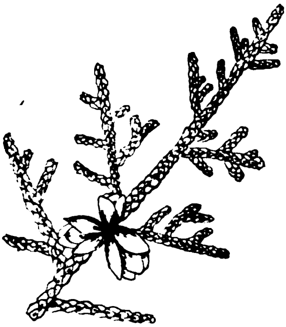


BALSAM FIR

Branchlet and cone, × ½

ARBOR VITÆ (WHITE CEDAR). *Thuya occidentalis* Linn.

This is a member of the cypress family, and the only one native to this latitude. It is popularly known in Vermont as the white cedar. This is an unfortunate misnomer, since the true white cedar is a different tree of more southern range. The arbor vitae is easily recognized by its striking pyramidal habit of growth and, upon closer examination, by its small, scale-like leaves, in four rows, but so flattened on the branchlets as to form fan-like sprays.



ARBOR VITÆ, × ⅔

It occurs commonly in the northern part of Vermont upon cool, moist hillsides and in swamps, becoming less frequent in the southern portions of the state. The bark and fibers twist spirally around the axis, making a shaft of great strength, and the straight slender trunks are of especial value for posts and telephone poles. Few timbers withstand decay in the soil better than the arbor vitae, fence posts sometimes lasting thirty or forty years. It is commonly planted for hedges and other ornamental purposes.

RED JUNIPER (RED CEDAR). *Juniperus Virginiana* Linn.

Three kinds of juniper are found in the state, but this one, commonly known as red cedar, is the only one which has the size and habit of a tree. It occurs on dry, rocky hills, being common along the bluffs of Lake Champlain, less so in the mountain range of southwestern Vermont. It occurs more or less commonly in the Connecticut valley north to Fairlee. (Flint).

RED JUNIPER, × 2/3

It somewhat resembles the arbor vitæ, from which it may be distinguished at a distance by its less symmetrical form and darker foliage. Closer inspection shows that its scale-like leaves have little tendency to the arrangement in a plane which is characteristic of the arbor vitæ. The fruit is also readily distinguishable from that of the other cone-bearing trees. It consists of thick fleshy scales which coalesce to form a structure looking more like a small berry than a cone, green in midsummer, becoming bluish at maturity in the autumn. The leaves of young shoots are longer than are those on the older branches, with needle-like points.

The heart-wood of this tree is soft, red and fragrant, and that obtained from the southern states is largely used in the manufacture of pencils. Most of the Vermont trees are used for fence posts, which are found to be very durable. In some localities of the state oil is distilled from the leaves and wood.

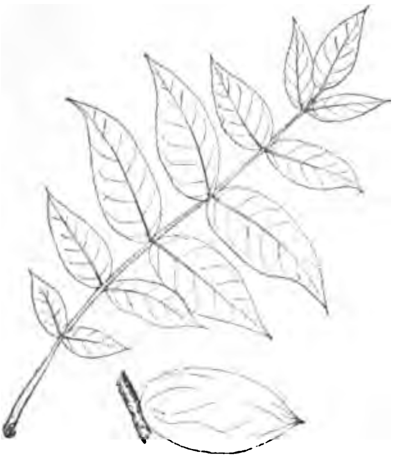
The branches are often loaded with "cedar apples." These are fungus growths and are noteworthy because the spores from them develop as a destructive rust upon adjacent apple trees. Hence red cedars should not be planted near an orchard.

## WALNUT FAMILY

### BUTTERNUT (WHITE WALNUT). *Juglans cinerea* Linn.

Every school boy in Vermont has some acquaintance with this tree and its sweet tender nuts. It occurs along the hillsides and river valleys throughout the state. The staminate flowers, appear in May and hang in graceful, slender catkins five or six inches long. These are generally found on the second year shoots while the fruit-bearing flowers are borne on the terminal shoots. Butternut trees show some irregularities, however, in reference to the time and order of the appearance of the two kinds of flowers so that the pollen-bearing clusters may mature either some ten days earlier or later than the fruit-bearing ones on the same tree. This may be the cause of the variability often noticed in the crop of butternuts. The peculiarity offers an interesting subject for further observation.

The meat of the butternut needs no recommendation but the excellencies of pickles made from the young mucilaginous nuts are not so well



BUTTERNUT.
Leaf and fruit, × ⅓

known. For this purpose they should be gathered early in June and the clammy pubesence removed by plunging them into boiling water and rubbing with a coarse cloth.

The wood of the butternut is soft and not strong but takes a beautiful, dark polish and is used especially for interior finishings.

*Introduced species.*—The black walnut is occasionally cultivated. It may be transplanted or grown directly from the nuts, and develops rapidly into a beautiful tree, valuable for both its nuts and wood.

### THE HICKORIES

The hickories are stately trees, quite generally distributed throughout the United States. There are eight species, all peculiar to America, several of which produce edible nuts. Among the latter are the shellbark hickory in the north and the pecan in the south.

The flowers, arranged in catkins of the two kinds, appear in late spring after the unfolding of the leaves.

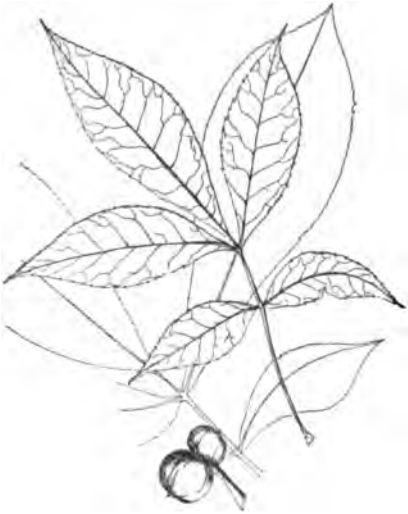
The wood of all these trees is heavy, tough and durable. It is used for axe handles, agricultural implements and in places where strength and elasticity are required it is almost unrivaled.

The hickories are frequently but erroneously termed "walnuts," in the popular language of New England. The true walnuts of which the butternut and black walnut are the American representatives differ from the hickories, although they are closely related.

**Nut sweet and edible, bark shaggy, leaflets 5 (rarely 7).............Shellbark Hickory**
**Nut more or less bitter, not edible, bark close.**
  **Fruit globular, nut thin-shelled, leaflets 7-11...................Bitternut Hickory**
  **Fruit pear-shaped, nut hard-shelled, leaflets 5-7.................Pignut Hickory**

### SHELLBARK HICKORY (SHAGBARK HICKORY, WHITE WALNUT). *Hicoria ovata* (Mill.) Britton, *Carya alba* Nuttall.

Two points alone are sufficient to distinguish the shellbark from other hickories ; its dark brown bark scaling off irregularly in long slender strips and its compound leaves rarely consisting of more than five leaflets. This

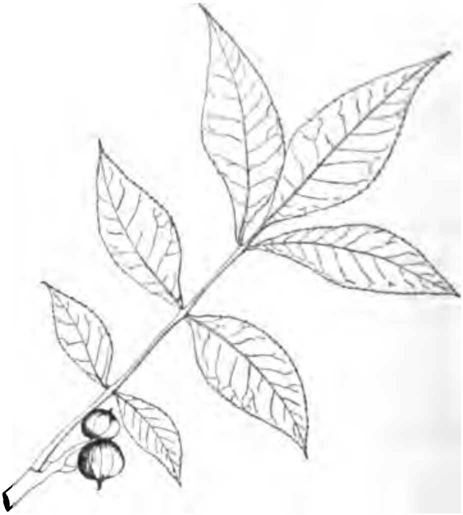


**SHELLBARK HICKORY**
Leaf and young fruit, × ⅓

is the hickory nut of the markets. It is quite common in the moist soils of the Champlain valley. It occurs in the Connecticut valley as far north as Windsor also in the White river valley at Royalton. There is a large grove on the south side of Bald Mountain in Shrewsbury at an altitude of about 1500 feet. The value of hickory timber for certain manufacturing purposes has already been mentioned. It is also valued for fuel, yielding more heat to the cord than any other native tree.

BITTERNUT HICKORY (BITTER WALNUT). *Hicoria minima* (Marsh.) Britton, *Carya amara* Nuttall.

Three characteristics of the bitternut are to be kept in mind in distinguishing it from the pignut, namely, its globular, thin shelled nuts, its small, pointed, yellow buds and its leaves consisting of seven or more slender leaflets. The bitternut does not occur in our mountain forests but is not uncommon with the shellbark in the Champlain and Connecticut valleys. Besides being a desirable ornamental tree, the bitternut produces wood scarcely inferior to that of the shellbark hickory for fuel or manufacturing purposes.

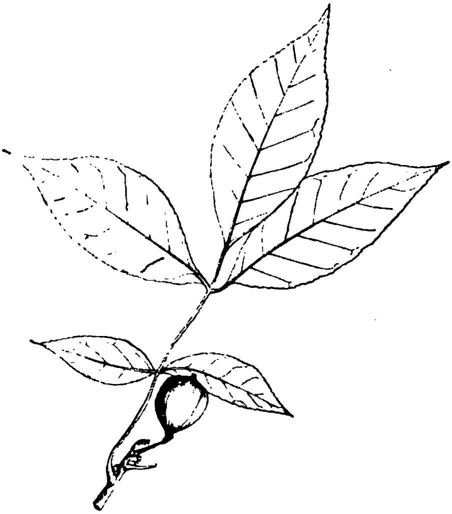


**BITTERNUT HICKORY**
Leaf and fruit, × ⅓

**PIGNUT HICKORY.** *Hicoria glabra* (Mill.) Britton, *Carya porcina* Nuttall.

This species is apparently confined to the southeastern and southwestern portions of the state. The following statements summarize the present information as to its distribution. It is a common tree in the Hoosac valley, Pownal, and a large grove occurs on the shore of Lake Bomoseen, West Castleton (Eggleston). There are a few trees near the Hubbardton line in East Castleton, (G. H. Ross). In the Connecticut valley it is abundant on the hills near the river in the vicinity of the Massachusetts line, but is not common above Bellows Falls, (Flint).

Observers of trees in southern Vermont should strive further to increase our knowledge of its distribution.



PIGNUT HICKORY
Leaf and fruit, × ⅓.

In distinguishing this from the bitternut, notice the pear-shape fruit, thick-shell nut, the generally smoother bark and the fewer leaflets, (5-7, rarely 9.) It reaches its most northern limit in this region and will probably be found only in the more sheltered river or lake valleys. The lumber of the pignut is of similar value to that of other hickories and is used for like purposes.

## WILLOW FAMILY

### THE WILLOWS

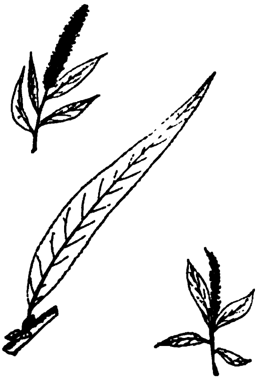
The amateur botanist who tries to distinguish the willows, soon finds himself in an inextricable tangle. This is partly because several European species and varieties have been naturalized and partly because the willows hybridize and rehybridize so frequently. Fourteen native and three introduced species are found in Vermont, only three of which attain the size of trees. The shrubby species vary in height from the common pussy willow (*Salix discolor*) which is sometimes fifteen or twenty feet high and almost a tree, down to the prostrate alpine willows found only under the northwestern slope of the "chin" of Mt. Mansfield, where they raise their heads but a few inches above the moss in which the stems are imbedded.

Willows are commonly introduced as shade trees because they are so easily propagated by cuttings. Care should be taken, however, to select the stamen-bearing trees, both because these are more ornamental when in flower and because they do not produce the downy fruit which is often disagreeable when they are growing near houses.

The following key, while not entirely satisfactory, may aid in recognizing the three tree willows.

| | |
|---|---|
| **Smaller, slender, native trees, bark rough, twigs dark** | **Black Willow** |
| **Larger, spreading, introduced trees.** | |
| **Twigs yellow, young leaves ashy-gray or silver-white on both sides** | **White Willow** |
| **Twigs blue-green, young leaves green above, paler beneath** | **Crack Willow** |

### BLACK WILLOW. *Salix nigra* Marsh.



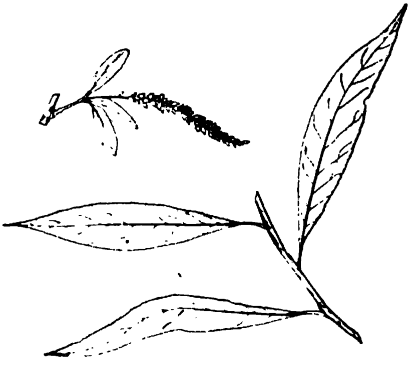
BLACK WILLOW

**Leaf and flowers, staminate above, pistillate below, × ⅓.**

The black willow is a slender, rather graceful tree, common everywhere, along the banks of lakes and streams. It may usually be recognized by its stouter dark brown or black twigs in contrast with the more slender, yellowish or bluish-green twigs of the European species. When the pendulous catkins open, three, five or more stamens may be found in each tiny flower. The leaves are green when mature and smooth except on the mid-veins and petioles.

### WHITE WILLOW (YELLOW WILLOW). *Salix alba vitellina* Koch.

The white willow was introduced from Europe, but it has been so commonly planted and is so frequently spontaneous along the banks of streams and lakes, that it merits a place in this list. If one observes closely the tiny staminate flowers in May both this and the next species are clearly distinguished from the black willow since there are but two stamens in each flower, whereas the black willow has from three to six. Usually, however, one must depend upon other and less definite characters. A little practice, following the suggestions giv-



WHITE WILLOW

**Leaves and pistillate flower, × ⅓.**

en in the above key, will enable one to distinguish the native black willow from the introduced species. Nor will it be found difficult to distinguish typical trees of the white willow from typical trees of the crack willow by the characters given in this key. As a matter of fact, however, there are numerous varieties and hybrids between these two willows which it is impossible to classify under either name.

The white willow is large and graceful, and this, coupled with the ease of starting it from cuttings, makes it a deservedly popular shade tree.

### CRACK WILLOW. *Salix fragilis* Linn.

Most of the statements made in the discussion of the white willow apply to this species also. A distinctive characteristic of the twigs, aside from their color, is that they are very brittle, especially near the base, whence the name.

## THE POPLARS.

The poplars belong to the willow family and resemble the willows especially in flower and fruit characters. The nodding, worm-like, staminate and pistillate catkins are borne upon different trees and, opening before the leaves, are conspicuous in early spring. The poplars are quite widely distributed, extending from the Arctic circle to Mexico and from the Atlantic to the Pacific.

The wood of poplars is very soft and light and especially liable to warp, but is cheap and useful for making toys, boxes and smaller furniture. Much of it now goes to the pulp mills.

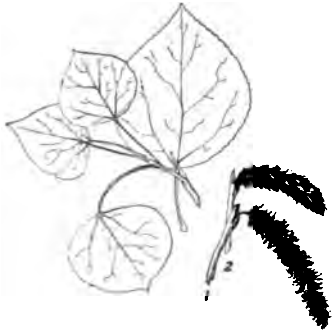
**Leaves coarsely and bluntly toothed or scalloped.**
  **Leaves roundish, especially at the base..............................Largetooth Aspen**
  **Leaves triangular, with straight or truncate base.........................Cottonwood**

**Leaves finely toothed.**
  **Leaves small, nearly as broad as long, petioles much flattened.......American Aspen**
  **Leaves larger usually much longer than broad, petioles not flattened. Balsam Poplar**

*Introduced species.*—In addition to these native poplars two European species are very commonly planted, the Lombardy poplar, (*P. nigra Italica*) recognized by its tall spire-like form, and the white poplar, (*P. alba*) easily distinguished by its leaves, green above and very white-cottony beneath.

### ASPEN (AMERICAN OR QUAKING ASPEN). *Populus tremuloides* Michx.

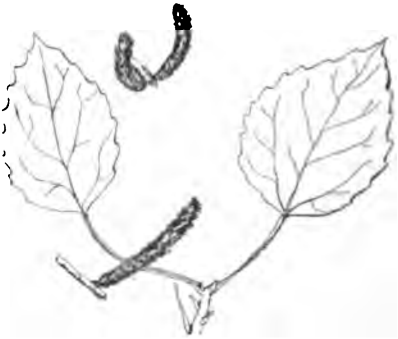
The most careless observer cannot have failed to notice the leaves of the aspen continually trembling on the quietest summer day. This tremulousness has, indeed, given name to the species. The reason for it, as may readily be seen by examination of any leaf, lies in the decidedly flattened structure of the leaf-stem or petiole. The slender drooping catkins appear in early spring and the downy fruits ripen in the latter part of May. The American aspen grows to a medium size, and is the most widely distributed tree in North America, extending from Labrador to Alaska, from Lower California to the Atlantic coast. It is found everywhere in Vermont.



AMERICAN ASPEN
Leaves and flowers,
1 staminate, 2 pistillate, × ⅓.

LARGETOOTH ASPEN. *Populus grandidentata* Michx.

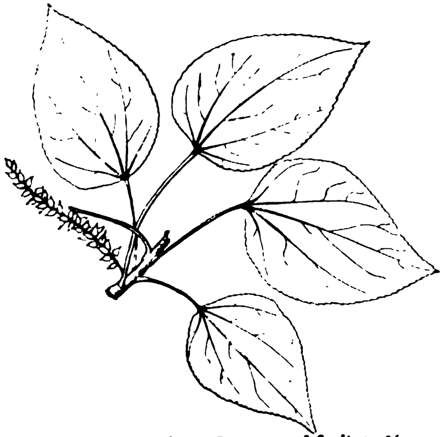
The name of this tree suggests an easy way of identifying it. The coarse toothed margin of the leaf is a constant characteristic and may be relied upon. The pollen-bearing catkins may be seen first, a little later the seed-bearing catkins appear on other trees. The fruits ripen when the leaves are unfolding. The young leaves are downy-white on both sides, but later become green and smooth. The largetooth aspen is of common occurrence in Vermont. It flourishes best on rich sandy soil.



LARGETOOTH ASPEN
Leaves and flowers, pistillate above,
staminate below, × ⅓.

BALM OF GILEAD (BALSAM POPLAR). *Populus balsamifera* Linn.

This tree, common on the banks of streams and along our roadsides, is a northern species ranging from northern New England far north to the Alaskan coast. It is subject to great variation in the form of the leaves. Some are almost triangular with a deeply heart-shape base, while others are very slender with a wedge-shape

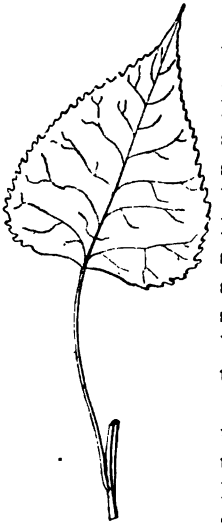


BALM OF GILEAD, Leaves and fruit, × ⅓.

base. The buds and young leaves are covered with a gummy excretion which is sometimes soaked out and used in preparing ointments. It is frequently planted as a shade tree.

A variety of this species (var. *candicans* Gray) has broader leaves, more inclined to heart-shape and minutely hairy on the petiole and margins. It is to be sought along our northern borders and in cultivation.

COTTONWOOD. *Populus deltoides* Marsh., *P. monilifera* Ait.



COTTONWOOD, × ⅓.

In Vermont the cottonwood occurs native in the valley of Lake Champlain and along its tributary streams, and south in western Vermont to the Hoosick valley in Pownal where it is particularly abundant. It occurs along the Connecticut river in southeastern Vermont at least as far north as Brattleboro. It has been planted as a shade tree in other localities. For this purpose the stamen-bearing trees should always be chosen since the abundant, cottony, seed is a nuisance near dwellings. The leaves occasionally vary to a heart-shape or even wedge-shape base, but the deltoid (triangular) form is so characteristic as to give name to the species.

The cottonwood is the most massive of our deciduous trees, sometimes 100 feet in height and with a trunk 5 to 7 feet in diameter. Such isolated giants have become the familiar landmarks of many roadsides near Lake Champlain.

## BIRCH FAMILY

### THE BIRCHES

The birches are widely distributed over the old and the new worlds, being most abundant in the higher latitudes. Nine species occur in North America, four of which are found in Vermont. They are all graceful trees with slender flexuous branches and delicate foliage. Both the fruit-bearing and pollen-bearing flowers are found on the same tree, but in separate clusters. The staminate catkins are long and drooping, while the pistillate are shorter and not pendulous until fruited.

The wood of birches is valued chiefly for cabinet making, for spools and other small articles.

The following key is based largely on the bark characters. It is to be noted that these characters are not well developed on saplings and may be lost on some old trunks.

**Bark white.**

**Leaves nearly triangular, saw-tooth or lobed, long taper-pointed, bark close........................................................White Birch**

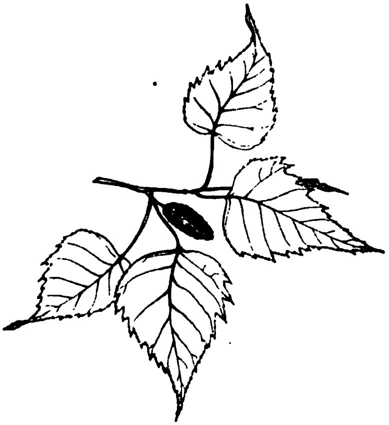
**Leaves ovate, saw-toothed, bark in easily separable layers, often ragged..Paper Birch**

**Bark dark-brown or black, close, sweet, aromatic..............................Sweet Birch**

**Bark silvery-yellow, in layers, often ragged....................................Yellow Birch**

*Introduced species.*—The European white birch (*B. alba*) is commonly planted for ornamental purposes. It is a beautiful tree closely resembling the native white birch. There are numerous horticultural varieties, some with finely cut leaves and pendulous branches.

### WHITE BIRCH (GRAY BIRCH). *Betula populifolia* Marsh.



WHITE BIRCH
Leaves and fruit, × ⅓.

The white birch is at best but a small, short-lived tree, but it grows in such numbers that it is sure to attract attention. The points which distinguish this birch are its triangular, slender, taper-pointed leaves, smooth-shining on both sides, and its smooth, close, creamy-white bark. Both the staminate and the pistillate catkins open before the leaves in the spring.

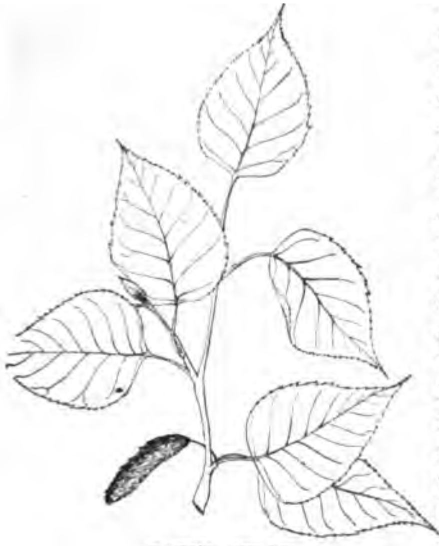
It is most abundant in the lighter soils, either moist or dry in the Champlain valley. It never reaches the higher altitudes, 1800 feet being the highest reported by Dr. Sargent. In the Connecticut valley it is reported by Flint only as far north as Westmoreland, N. H.

It never reaches sufficient size to become a valuable lumber tree, but its light elastic stem is always in demand for spools, shoe-pegs, and barrel-hoops.

The white birch with its white trunk and graceful branches and light, delicate foliage is one of our most beautiful trees, but its desirability for transplanting is lessened by its short life and liability to injury from storms.

### PAPER BIRCH (CANOE BIRCH). *Betula papyrifera* Marsh.

The paper birch is found in cool soils in all parts of the state, being typically a tree of more northern distribution than is the last species. It is, however, often intermingled with the white birch and is popularly confused with it, although careful observation reveals many characteristics by which



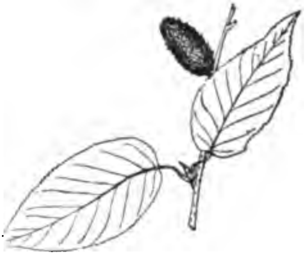
PAPER BIRCH
Leaves and fruit, × ⅓.

the two may be distinguished. The paper birch is a larger tree than the white and more widely distributed. The two species are similar in the chalky whiteness of the bark, but that of the white birch clings closely so that it cannot be separated in large layers, whereas the peculiar character of the paper birch is the ease with which ample sheets of the beautiful corky layers may be removed. The larger size of the paper birch makes its lumber more useful for manufacturing purposes than that of the white. A dwarf form known as variety *minor*, which reaches a height of but a few feet occurs on the exposed summit of Mt. Mansfield.

### SWEET BIRCH (BLACK BIRCH, CHERRY BIRCH). *Betula lenta* Linn.

The distinctive characters of this tree are well known to many Vermonters, who, as children, have become familiar with the sweet wintergreen flavor of bark and leaves. It is common in western Vermont, but reaches only the foot-hills of the Green Mountains. Its northern limit in the Connecticut valley is in the vicinity of Norwich.

The two kinds of catkins are noticeable upon the bare trees in winter; and they open on the first spring days, before most other trees have made a visible response to the sun's rays. The wood is hard, strong and valuable for furniture and fuel.



SWEET BIRCH
Leaves and fruit, × ⅓.

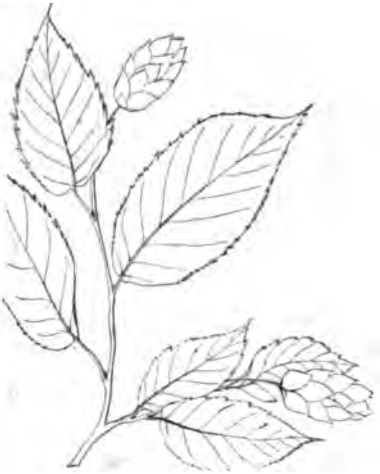
### YELLOW BIRCH (GRAY BIRCH). *Betula lutea* Michx.

The polished silvery-yellow bark of the mature tree marks the yellow birch almost as clearly as does the white bark in the case of the preceding species. On the oldest trees in the primeval forest, however, the bark becomes a darker bronze and rough. It is common in nearly all parts of Vermont, but especially in rich, cool soils, and it extends far up the sides of our higher mountains. During the winter the little catkins remain tightly closed, but by June they lengthen into slender, drooping clusters. Yellow birch lumber is valuable for many purposes. It takes a beautiful polish, and is becoming increasingly popular for furniture and for flooring.

Because of its graceful form and attractive, yellow bark, it merits more general usage for ornamental planting.

The general similarity of the leaves and fruit of this species to those of the paper and black birches, renders further illustration unnecessary.

**HORNBEAM (IRONWOOD, LEVERWOOD, HOP HORNBEAM).** *Ostrya Virginiana* (Mill.) Koch.



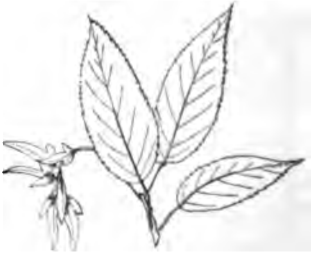
HOP HORNBEAM
Leaves and fruit, × ⅓.

Hornbeams are sometimes mistaken and transplanted for elms, owing to the general similarity in the appearances of the young trees. The leaves of the hornbeam, however, are nearly symmetrical at the base, while those of the elm are more unequally developed. In late summer the hornbeam is easily distinguished by its fruit hanging in hop-like heads.

The hornbeam is quite generally distributed, both in the valleys and the mountainous parts of the state, but is most common in the western and southern portions. It is a small tree. The wood is very strong, tough, and durable in contact with the soil, hence the names ironwood, lever wood. It is used for levers, mallets and for fencing materials.

**BLUE BEECH (WATER BEECH, HORNBEAM, IRONWOOD).** *Carpinus Caroliniana* Walt.

The blue beech is a small, bushy tree rarely over twenty feet high. It is not uncommon in moist soil along streams, but does not reach the higher altitudes. It is distinguished in spring by its tiny flowers arranged in loose racemes and in July by the curious leaflike wings which develop upon the fruit. A glance at its trunk makes its recognition certain at any time of year,



BLUE BEECH
Leaves and fruit. × ⅓

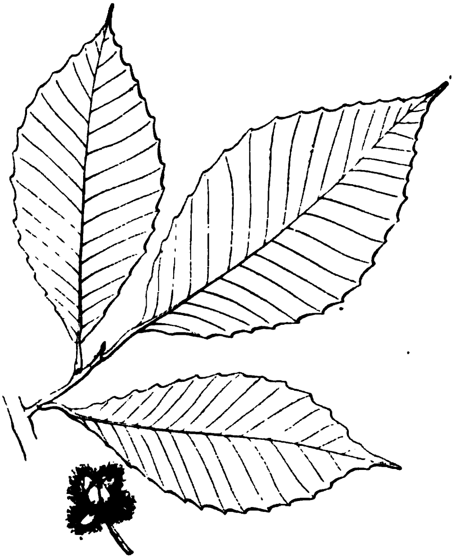
however. This has a close, gray bark resembling that of the beech but with furrows and ridges suggesting the muscles of a strong man's arm. It is the toughest of all our woods.

## OAK FAMILY

**BEECH.** *Fagus Americana* Sweet, *F. ferruginea* Ait.

The beech, when growing in the forest, with its tall, graceful trunk, its smooth, gray bark and shiny leaves, is a handsome tree. It is not only one of the most common trees in Vermont, but also one of the most widely distributed in eastern North America.

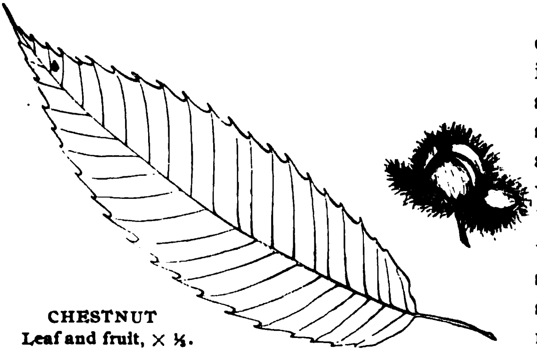
The drooping clusters of pollen-bearing flowers and the short, stout fruit-bearing heads open under the newly spreading leaves in early May. The burs open and the nuts fall with the first frosts of autumn. There is a popular saying that beech nuts occur plentifully only once in seven years. There certainly is great irregularity in the fruiting of the beech. What is the reason? This is an interesting question for some one to investigate.



BEECH
Leaves and fruit, × ⅓.

The wood is quite hard and makes the best of flooring. It is also used in the manufacture of bench planes and similar tools and for fuel.

**CHESTNUT.** *Castanea dentata* (Marsh.) Bork., *C. sativa Americana* Wats.



CHESTNUT
Leaf and fruit, × ⅓.

Unfortunately the chestnut is not found in most parts of the state. It occurs in southeastern Vermont along the Connecticut valley as far north as Windsor. In the southwestern part of the state it is found well scattered in the Taconic range from Pownal to

Manchester. A grove occurs at West Rutland and there are native trees upon Rock Point near Burlington. This is the most northern station in New England. The chestnut will probably grow in all parts of the state and may well be cultivated both for its delicious nuts and for its beauty as a shade tree.

The leaves are shiny and graceful, from six to eight inches long. When they are nearly grown, long, stiff catkins of fragrant, greenish-yellow flowers appear. These bear the pollen, the fruit-bearing flowers being smaller, enclosed in bur-like scales. The nuts, two or three in a bur, ripen in October.

## THE OAKS

The oaks, abundant throughout the northern hemisphere, are remarkable for their massive trunks, for their thick, rugged bark and large, strong roots. They are distinguished from all other trees by their cupped fruit, but many who have seen these fruits have not noticed the small, scaly masses of flowers which produce them. The pollen-bearing flowers are found on the same tree, but are arranged in long, slender catkins consisting of a cluster of from three to twelve stamens. Some of the oaks, including the red and black, do not mature their fruit until the second year.

Oak timber is of great commercial value, being used for a variety of purposes. For strength, hardness, toughness and durability combined, it is unsurpassed.

The oak genus is a large one. Ten species are known to occur in Vermont, and these sometimes hybridize, producing intermediate forms. The bear oak or scrub oak, *Q. nana* (Marsh.) Sarg., is a straggling shrub, occurring sparingly in southeastern Vermont. The dwarf chinquapin oak, *Q. prinoides*, Willd., is also a rare shrubby species; dry hillsides, Pownal (Robbins, Eggleston), Weybridge (Brainerd). The other eight species are trees. Of these three are rare or local in their occurrence, as follows:

Chinquapin oak, *Q. acuminata* (Michx.) Sarg., (*Q. Muhlenbergii* Engelm.), Gardiner's Island, Lake Champlain (Pringle).

Bur oak, *Q. macrocarpa* Michx., in the Champlain valley, more common in Addison county than elsewhere.

Scarlet oak, *Q. coccinea* Wang, Pownal (Eggleston).

The other five are of more common occurrence; the following key will aid in distinguishing them.

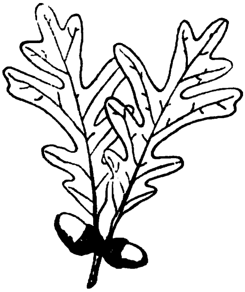
**Lobes of leaves obtuse, not bristle-pointed, fruit annual.**

- **Leaves usually deeply-lobed (½- or ⅔-way to midrib) ........................ White Oak**
- **Leaves scalloped or shallow-lobed (less than ⅓-way to midrib), stalk of acorn much longer than leaf-stalk ........................................ Swamp White Oak**
- **Leaves undulate-toothed (crenate), stalk of acorn shorter than leaf-stalk .. Chestnut Oak**

**Lobes of leaves acute, bristle-pointed, fruit biennial.**

- **Acorn large, cup ¾-1 inch broad, shallow, saucer-shaped ...................... Red Oak**
- **Acorn small, cup ½-¾ inch broad, hemispherical or top-shaped ............ Yellow Oak**

### WHITE OAK. *Quercus alba* Linn.



**WHITE OAK**
Leaves and fruit, × ½.

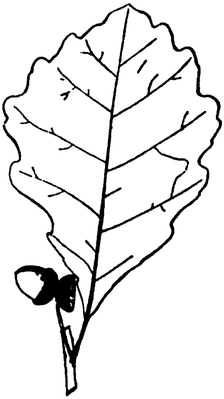
The white oak is the most beautiful as well as the most useful of the oaks found in this part of the United States. Vermont has quite a generous supply of these trees in the Champlain valley. Flint states that it occurs but sparingly in the southern Connecticut valley and disappears before the mouth of the Passumpsic is reached. Both kinds of flowers appear at the same time, the staminate being more conspicuous on account of their drooping clusters. The acorns ripen and fall during the first autumn.

The tough, heavy wood of the white oak needs no recommendation. On account of the beauty of its grain and its capability of taking a high polish, it is extensively used for furniture and for inside finishings. It is also much used in carriage manufacture and for car and bridge timbers.

The famous "Charter Oak" of Connecticut was of this species.

### SWAMP WHITE OAK. *Quercus platanoides* (Lam.) Sudworth, *Q. bicolor* Willd.

In beauty and variety of grain this tree nearly equals the white oak and its wood is valuable for similar purposes. As its name suggests it grows in low, moist soil. Unfortunately the swamp oak is not found in Vermont except along the intervales of Lake Champlain and its tributaries. Here it is quite abundant and its majestic size and symmetrical, rounded top make it a conspicuous and beautiful tree. It is more easily identified than many of the oaks because of the scaly bark, the leaves downy on the lower surface and the long, downy stalks of the acorns. The flowers open late in May and the fruits ripen the following autumn.



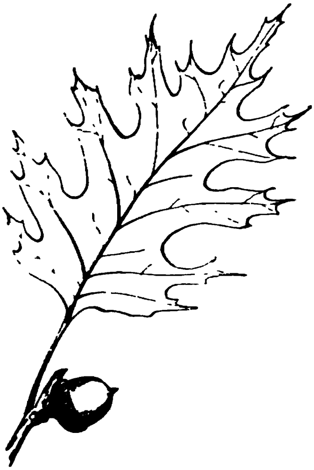
**SWAMP WHITE OAK**
Leaf and fruit, × ⅓.

### CHESTNUT OAK. *Quercus prinus* Linn.

The popular name of this oak is suggested by the marked resemblance of its leaves to those of the chestnut. It is one of the common oaks from Massachusetts and New York southward, forming a large tree on rocky hillsides, often associated with the chestnut. The line of its northern distribution passes through the Champlain valley. It is common on Snake mountain and the quartzite range of the Green mountains in Addison county (Brainerd) and thence south through Rutland and Bennington counties. It probably occurs in the southeastern part of the state also.

The acorns are large, one inch or more in length. The wood is hard and tough and is frequently used for railroad ties.

RED OAK. *Quercus rubra* Linn.



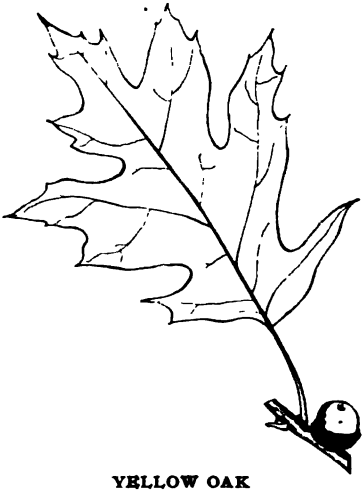
RED OAK
Leaf and fruit, × ⅓.

The red oak is the most northern of all the oaks, ranging from Nova Scotia to Tennessee. It is generally distributed through the Champlain and lower Connecticut valleys where it is the most common oak. It is less common in the northern part of the Connecticut valley. The flowers appear in May but the sessile, shallow-cupped acorns do not ripen until the second autumn.

The wood is lighter in weight and more brittle than that of the white oak but when quartered shows a beautiful grain and is used for furniture. It is also valued for bridge posts where there is to be exposure to water. The wood drys out slowly and is inferior as fuel.

YELLOW OAK (BLACK OAK). *Quercus velutina* Lam., *Q. coccinea tinctoria* Gray.

The yellow oak is a southern species which reaches its northern limit in Vermont. It is not uncommon in light, dry soils in the Champlain valley and it occurs also in the southern part of the Connecticut valley. The two common and apparently incompatible names, yellow oak and black oak, arise from the diverse colors of the inner bark and the outer bark. The former, which is used in tanning, is yellow, while the latter is very dark. The leaves are rather large, dark, shiny green with yellowish petioles. The acorns do not ripen until the second autumn. The wood is hard and tough like that of the white oak and is used in manufacturing.



YELLOW OAK

Leaf and fruit, × ⅓.

## ELM FAMILY

### THE ELMS

We are fortunate in having in Vermont all of the elms of the eastern United States except one small southern species. The tiny greenish flowers have no petals but gracefully fringe the bare trees with their long, slender stamens in early spring before the appearance of the leaves. The fruits are supplied with a disk-like membranous wing. The leaves of all the elms have a peculiar oblique base, full and rounded upon one side, sharply wedge-shape on the other.

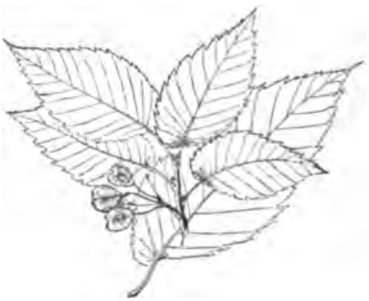
The three native species are readily distinguished as follows:

| | |
|---|---|
| **Inner bark mucilaginous** | **Slippery Elm** |
| **Inner bark not mucilaginous.** | |
| **Branchlets with corky wings** | **Cork Elm** |
| **Branchlets without corky wings** | **White Elm** |

*Introduced species.*—The English elm has occasionally been planted as a shade tree, although for such purposes it is less stately than our common white elm. Two European varieties have been more used for ornamental plantings, though each of them is rather curious than ornamental. These are the corky variety of the English elm, and the Camperdown or weeping elm, which is a variety of the Scotch elm. The young branches of the former are covered with conspicuous corky outgrowths, similar to those of the native cork elm, but more strongly developed. The American cork elm is distinguished from the English by its more downy bud-scales and by the production of flowers in elongated clusters (racemes), whereas those of the English elm are in close clusters. Other differences will readily be detected by those having occasion to compare the two trees. The weeping elm is usually grafted on an upright stock, leading to a peculiar umbrella-like development.

### WHITE ELM (AMERICAN ELM). *Ulmus Americana* Linn.

Of all the native trees none has done more than the white elm to beautify the streets of our cities and villages, or to grace our country hillsides and meadows. The spreading vase-shaped head is its typical form, but perfect trees are only found where there has been a free development of the branches from the sapling age. Even when developing freely, however, the trees vary markedly in form. Some may be found which are very

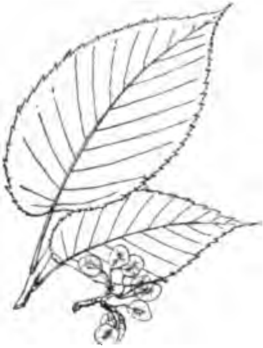


**WHITE ELM**
**Leaves and fruit, × ⅓.**

strict and upright; others which are straggling and strongly weeping. The bark characters also vary much in different trees. Numerous clusters of slender, drooping flowers open before the leaves in early May, giving the tree a delicate feathery appearance. The seeds mature and fall before the leaves are fully grown.

The wood is very tough and fibrous, making it useful for ox yokes, wagon bolsters, hubs of wheels and similar purposes where there is special cross-strain.

### SLIPPERY ELM (RED ELM). *Ulmus pubescens* Walt., *U. fulva* Michx.



SLIPPERY ELM
Leaves and fruit, × ⅓.

The slippery elm is not uncommon in Vermont. The scattering trees of this species are, however, usually passed unnoticed because it so closely resembles the American elm that it is not easy to distinguish the two by general appearance. The stringy mucilaginous bark of the slippery elm is always a sure means of recognition.

Other means of distinguishing it are found in its circular fruits, which appear in May; these have smooth margins, whereas those of both the other species are fringed with delicate hairs. The leaves are larger, rougher above and soft-downy beneath. But the surest and simplest test is the "slippery" bark. This has well known medicinal properties which give it a recognized value in the drug trade. The slippery elm prefers rocky ridges and hillsides.

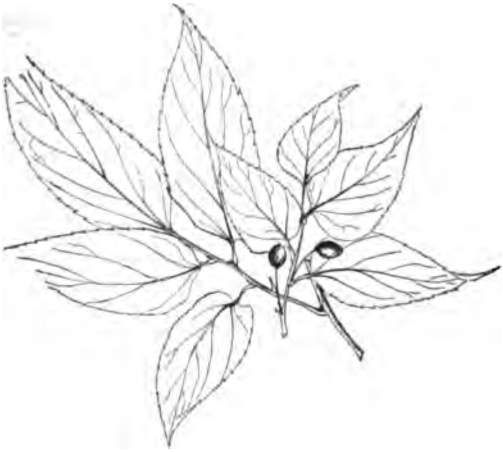
### CORK ELM (ROCK ELM). *Ulmus racemosa* Thomas.

The cork elm is a more valuable timber tree but it is found only in the limestone soils of western Vermont and there but rarely. Its peculiarity is a growth of corky ridges which sometimes project for half an inch or more from all sides of the younger branches. The leaves resemble those of the white elm but are more conspicuously downy upon the under side along the mid-ribs. The bud scales are also downy and the young branchlets somewhat so whereas those of the white elm are smooth. The flowers are borne in open branching clusters, or racemes, and this characteristic gives the Latin name to the species. The fruit, which matures when the leaves are half grown, is somewhat larger than that of the other elms.

### HACKBERRY (NETTLETREE). *Celtis occidentalis* Linn.

The hackberry is one of the rare trees of this state, occurring so far as is known only sparingly in the river bottom lands of the Champlain valley and the southern Connecticut valley. Its berries are dark purple when ripe and may remain on the tree all winter. They are about the size of peas, with a sweet flesh which is edible, and sought by the birds. Its fine form makes it a desirable shade tree.

It so closely resembles the elms that it is easily mistaken for one of them and because of this it is doubtless frequently passed unnoticed even by botanists.



**HACKBERRY**
Leaves and fruit, × ½.

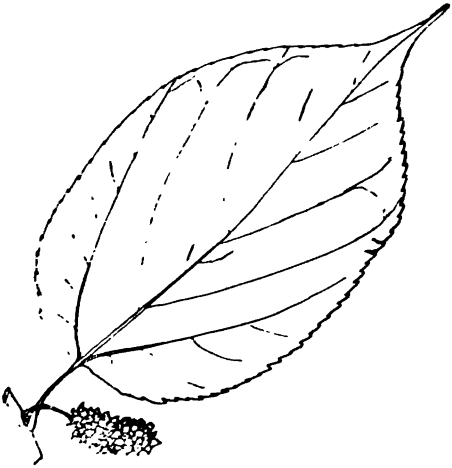
### MULBERRIES.

The name mulberry is very commonly applied in Vermont to one of the wild raspberries, which has a conspicuous rose-like blossom followed by a reddish raspberry fruit. This shrub should be called the purple flowering raspberry since the true mulberries are trees. Two species of mulberry occur in Vermont; of these, the red is native, and the white is introduced.

The fruit of both is edible somewhat resembling that of the blackberry in size and appearance. The leaves are heart-shape or ovate, often cut into curiously irregular lobes so that no two leaves on a branch will be exactly alike. This irregularity in leaf-form, together with the peculiar fruit, makes the recognition of the mulberry easy. It is often difficult to distinguish the two species, however. The following key will aid in this:

| | |
|---|---|
| Leaves bright and smooth, mostly glossy above.................... | White Mulberry |
| Leaves dull green, upper surface rough.............................. | Red Mulberry |

**RED MULBERRY.** *Morus rubra* Linn.



RED MULBERRY
Leaf and fruit, × ⅔.

The red mulberry was discovered at Pownal in southwestern Vermont by William Oakes some seventy years ago. W. W. Eggleston recently found a few trees near Pownal showing that it still occurs there occasionally at least. It is typically a more southern tree and this station is probably nearly at its northern limit. It becomes a tree of medium size at the south, but these Pownal plants were scarcely more than shrubs, six to fifteen feet in height. Students of trees in the southern counties should be on the lookout for it elsewhere.

**WHITE MULBERRY.** *Morus alba* Linn.

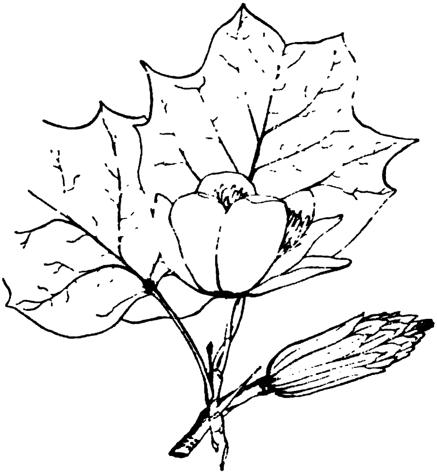
Some years ago there was considerable discussion and some experiments upon the feasibility of silk-worm culture in the United States. At this time the white mulberry was planted in many places in the state. These trees have proved hardy and occasionally spontaneous seedlings have appeared.

## MAGNOLIA FAMILY

**TULIPTREE.**

*Liriodendron tulipifera* Linn.

The tuliptree is included in this list of native Vermont trees, although few native trees can be pointed out. The tree was authentically reported in the Appendix to Thompson's Vermont in 1853. It then occurred occasionally in Bennington county along the Hoosick river. A single native specimen of it was recently reported from North Pownal by Eggleston, showing that it is not yet extinct. It is to be hoped that tree lovers located in that



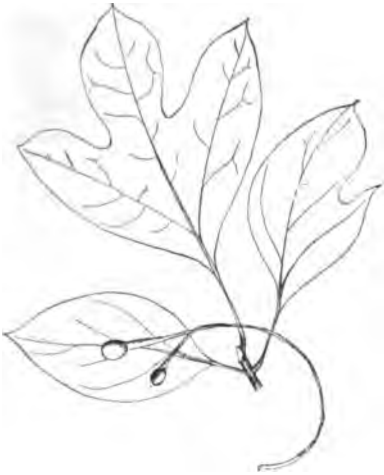
TULIPTREE
Leaves, flowers and fruit, × ⅓.

portion of the state will learn and more fully report upon its present distribution as this region marks its northern limit as a native tree. It thrives, however, as a shade tree planted in yards in Rutland and Burlington.

An attractive feature of this tree is its display of tulip-like flowers which open in June. The leaves are curiously four lobed, or lyre shape, as is well shown in the figure, light green above and whitish below.

## LAUREL FAMILY

SASSAFRAS. *Sassafras Sassafras* (Linn.) Karst., *S. officinale* Nees.



SASSAFRAS
Leaves and young fruit, × ½.

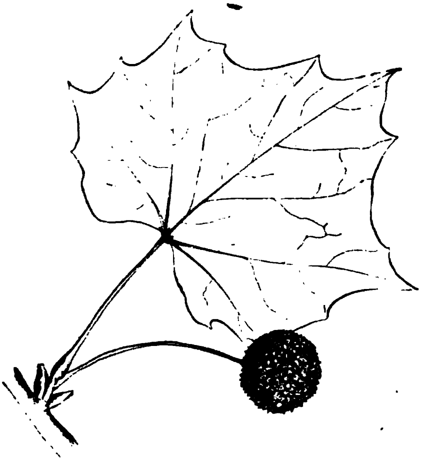
The sassafras reaches its northern limit in southeastern Vermont where it occurs sparingly in sandy soils in the lower Connecticut valley. It is also found in Pownal, and should be looked for further north in western Vermont. The leaves have many interesting variations in form. Some are ovate and entire while others are deeply three lobed. These with intermediate forms may be found on the same tree. Its bright blue fruits ripen in September and are eagerly devoured by the birds. The root of this tree furnishes the sassafras bark of commerce. When transplanted it makes an interesting and rather ornamental tree.

## PLANETREE FAMILY

SYCAMORE (BUTTONWOOD). *Platanus occidentalis* Linn.

The sycamore occurs sparingly in the Champlain and the lower Connecticut valleys, and their tributaries. It is also abundant in the Hoosac valley, in southwestern Vermont. It is at its northern limit in this state and as a consequence no very large trees of it occur. In the lower Ohio and Mississippi valleys, where it is more fully at home, the sycamore develops into the largest tree of eastern North America, occasionally reaching a height of 150 feet and a diameter of 15 feet.

An unmistakable character of the tree is its bark. On old trees this is brown and rough on the lower parts of the trunk, but above and on the branches it is smoother with great irregular whitish or pale yellowish patches where the outer layers have scaled off leaving the inner bark exposed.



SYCAMORE
Leaf and fruiting head, × ⅓.

This gives the tree a whitewashed appearance when seen from a short distance.

The globular heads of fruit or "buttons" swing by their slender stalks until late in winter. The wood is hard and durable for many purposes. On account of its beauty and delicacy of color it is used for furniture, and inside casings.

It is a water loving tree, preferring the low, rich banks of streams, but will grow in drier soils. It is frequently planted as a shade tree. It is interesting and sometimes picturesque, but rarely ornamental as it grows in Vermont.

## ROSE FAMILY

### THE MOUNTAIN ASHES

The mountain ashes are conspicuous among our trees for their broad, flat-topped clusters of creamy-white flowers followed by the persistent scarlet fruits. The common name is suggested by the general resemblance of the compound leaf to that of the ashes. In reality these trees are very closely related to the cultivated apples and pears, a fact which will become evident if one examines the structure of either the flower or the apple-like fruit.

Two species of mountain ash are natives of the elevated parts of the eastern United States and both of these occur in Vermont. They are closely related and so similar that it requires careful scrutiny to distinguish them.

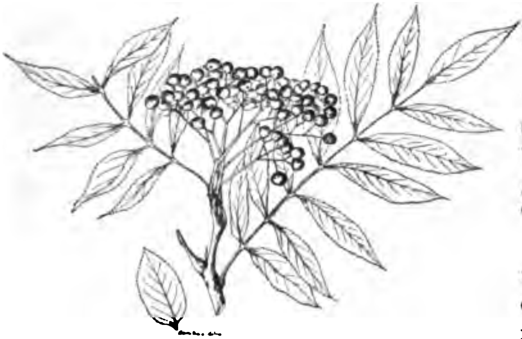
Leaflets with long tapering points, leaf-buds smooth, fruit ⅙ to ¼ inch in diameter........................................................American Mountain Ash
Leaflets broader more bluntly and shorter pointed, leaf buds sparingly hairy, fruit larger (⅓ inch in diameter)........................................Elderleaf Mountain Ash

*Introduced species.*—The native mountain ashes are not infrequently transplanted. The one most commonly used for ornamental purposes in Vermont, however, is the European mountain ash (*P. Aucuparia*). Plants of it are found abundantly spontaneous in groves at Burlington, evidently from seeds carried thither by birds. It is easily distinguished from either of the native species by the fact that its younger leaves are distinctly pubescent, with fine hairs on both surfaces, whereas the leaves of the native species are nearly or quite smooth. Both the flowers and the fruits of the European species are larger than those of the native.

There are several varieties of this or other European species in cultivation, including one that has pendulous or weeping branches, and one with leaves that are usually simple or divided only at the base, the oakleaf mountain ash.

### AMERICAN MOUNTAIN ASH. *Pyrus Americana* DC.

This is the more common native species. It is a small tree twenty-five to thirty feet high, scattered over the state but more frequent in the mountainous regions. The large flat clusters of whitish flowers open before the leaves are fully expanded. The leaf and fruit characters are well shown in the accompanying drawing. In color the fruit is bright red, and renders the trees especially conspicuous and attractive in autumn and early winter.



MOUNTAIN ASHES

Leaves and fruit of the American and one leaflet of the elderleaf. × ⅓.

### ELDERLEAF MOUNTAIN ASH. *Pyrus sambucifolia* Cham. & Schl.

This species is found near the summits of Mt. Mansfield, Camel's Hump, Willoughby and a few of the other higher mountains. It is not very common anywhere. This is not surprising since it is a northern tree and reaches its southern limit in New England, extending from here northward to Greenland and westward to the Rocky Mountains and Alaska. It is a small tree, or often a mere shrub when not favorably situated, with branches spreading into a rounded head. Sargent says that it reaches its best development in this region. It has been transplated occasionally in northern Vermont and has made a beautiful small shade tree.

The leaflets are seven to thirteen in number. One of them is included with the illustration of the American mountain ash that the two kinds may be compared. It will be seen that the elderleaf is shorter and broader with a tendency to be less pointed or even blunt at either end. It occurs so rarely, however, that there will be little opportunity for confusion between the two except by mountain climbers.

### APPLES AND PEARS.

The cultivated apples and pears are so closely related to the mountain ashes as to be placed by most botanists in the same genus with them. They are all introduced from Europe and Asia. The apple (*Pyrus Malus*) is frequently spontaneous, and many of the best varieties under cultivation in this country came from such American seedlings. The common pear (*Pyrus communis*) and the crab apple (*Pyrus baccata*) are both near relatives of the apple. Some of the larger improved varieties of the crab are probably hybrids with the common apple.

### SERVICEBERRY (SHADBUSH, JUNEBERRY). *Amelanchier Canadensis* (L.) Medic.

The shadbush is easily recognized by its graceful white flowers which appear in the most lavish profusion in May before those of any other native fruit tree. The fruits which ripen in June are a quarter of an inch long, purple, sweet and edible but the birds make way with them so quickly that they are not often to be found.

SERVICEBERRY
Leaves, flowers and fruit, × ½.

The shadbush is common in light soils and dry woodlands throughout the state, and especially so in parts of the Champlain valley.

It ranges in size and habit from a bush to a small tree of twenty to thirty feet. Like the other members of this family it is variable and there are also some smaller shrubby species[1] which very closely resemble it. Some of these are being cultivated for their fruits, and are said to be quite productive and desirable.

### HAWTHORNS

The haws, or as they are more familiarly known, the hawthorns or thornapples, have characters which render them conspicuous and familiar to everyone. They are all small trees, often shrubby in habit, with low crowns and spreading branches. These are usually covered in spring with clusters of attractive white flowers and loaded in autumn with fruit, which is apple-like, varying in color from red to yellow and in diameter from one fourth to three fourths of an inch or more.

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[1] "Probably six species, as follows: *A. Botryapium*, *A. oligocarpa*, *A. alnifolia*, *A. rotundifolia*, *A. spicata*, and an undescribed species." (W. W. E.)

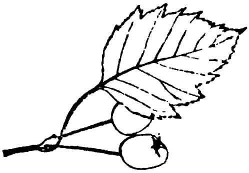
Several species of haw occur in this state. They are extremely variable and, indeed, are not at present fully understood by botanists. For this reason only the three most common and well marked species are included in the following key and descriptions.[1]

**Branches horizontal, gray, leaves wedge-shape at base, fruit yellow or red....Dotted Haw**
**Branches not horizontal (irregularly ascending), reddish.**
**Leaves thin, usually rounded or heart-shape at base, leaf-stalk slender, fruit coral-red................................................................ Scarlet Haw**
**Leaves thicker, shining, wedge-shape at base with leaf-tissue often extending down the short, stout leaf stalk, fruit bright, dark red...............Longspine Haw**

*Introduced species.*—In addition to these three species and the other native ones mentioned in the foot note, the English hawthorn (*Crataegus Oxycantha*) is often met. This has been planted as an ornamental tree and is sometimes found as an escape in woods or by roadsides. It is to be distinguished by its smaller fruit (one-fourth to one-third inch long) and distinctly cut-lobed leaves, wedge-form at the base. The flowers are large and showy.

### SCARLET HAW (SCARLET-FRUITED THORN, WHITE THORN). *Crataegus coccinea* Linn.

The scarlet haws (including the various forms, see foot-note) are the commonest of our hawthorns and are certainly well known to the children of Vermont, for who has not at sometime or other eaten thorn apples or woven caps with the sharp slender thorns? The white or pinkish flowers open in early June and are among the most beautiful found upon any tree. The scarlet apples are oblong and about half an inch in diameter. They ripen in September or October and often hang upon the trees until late fall. The scarlet haws are generally distributed through the lower altitudes in Vermont.



SCARLET HAW
Leaf and fruit, × ⅓.

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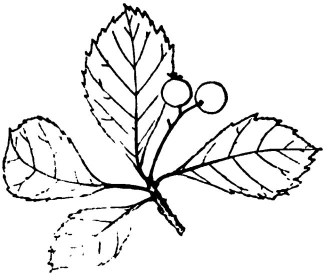
[1] Professor Sargent has recently made a critical examination of specimens of Vermont hawthorns sent him from various localities. Reports on these just as this is going to press indicate that a considerable revision of the botanical conception of some of the species is necessary. He distinguishes ten species among those submitted to him, as follows: *C. coccinea*, *C. macracantha*, *C. flabellata*, *C. intermedia*, *C. rotundifolia*, *C. populifolia*, *C. mollis*, *C. glandulosa*, *C. punctata*, *C. Crus-galli.* All of these except the last two are forms of what is included in Gray's Manual under *C. coccinea* and its varieties.

It is evident, therefore, that the hawthorns will present some interesting and perhaps rather puzzling questions to any one who undertakes careful observations upon them.

**LONGSPINE HAW.** *Crataegus macracantha* Loud., *C. coccinea macracantha* Dudley.

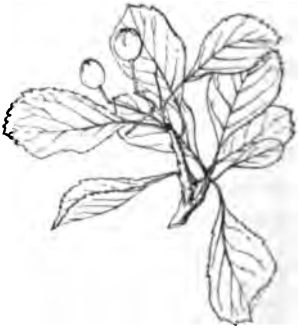


LONGSPINE HAW
Leaves and fruit, × ½.

This hawthorn is common in the Champlain valley and occurs in the Connecticut valley. It may therefore be expected along with the scarlet haw in most parts of the state. It closely resembles the scarlet haw in general appearance, but has spines somewhat longer, flower larger and borne in broader, stouter clusters. The fruit is rather smaller, round or compressed longitudinally. It is difficult to distinguish the species by these characters alone, however, and it will usually be necessary to appeal to the leaves in its identification. These are shining, thicker and more leathery in texture than those of the scarlet haw and have a wedge-shape base merging into a rather short stout petiole. A comparison of the figures will help make these distinctions clearer.

**DOTTED HAW (SPREADING THORN, DOTTED FRUITED THORN).** *Crataegus punctata* Jacq.

The dotted haw is a curious looking tree with stout branches spreading nearly at right angles to the trunk and forming a broad flat or terraced head. This character is more clearly seen in the older trees and when viewed from a short distance. Its identification may be made more certain by comparing the form of the leaves with the accompanying figure and also by noting the fruit characters. The fruits are larger than those of the scarlet haw, sometimes nearly an inch in diameter, turning dull red or yellow in autumn and marked with whitish spots. This last character has given name to the species. The dotted haw thrives best on rocky upland pastures and is not uncommon throughout the state.



DOTTED HAW
Leaves and fruit, × ½.

A form of this species (var. *canescens* Britton) has been found at Ferrisburg, which is densely whitish tomentose (hairy) on the lower leaf surfaces, and on the leaf and fruit stalks.

## THE PLUMS AND CHERRIES

The plums and cherries, particularly when in blossom, are among the most attractive trees in New England. They are all of small or medium size with conspicuous pink or white flowers. They are distinguished by their stone fruit and by their astringent bark and leaves.

There are five species found in Vermont. One of these, the sand cherry, is a small shrub usually nearly or quite prostrate and is found but rarely. One of the other four, the choke cherry, seldom attains to the size or habit of a tree, but it is deemed best to include it in this list since it occurs so commonly along with the tree species that the omission might lead to some confusion.

**Fruit red or yellow, flowers and fruit in short spreading clusters (umbel-like).**
  **Fruit small, ⅓ inch or less in diameter, bright red, small slender tree, bark light red-brown, leaves finely saw-toothed..............................Wild Red Cherry**

  **Fruit large, ½ inch or more in diameter, red or yellow, small tree, branches spreading, bark rough and dark gray, leaves coarsely saw-toothed...............Canada Plum**

**Fruit black, flowers and fruit in long, slender clusters (racemes), bark grayish.**
  **Shrub, fruit very astringent, leaves sharply saw-toothed...................Choke Cherry**

  **Large tree, bark rough and black, fruit slightly astringent, leaves with teeth incurved..................................................Black Cherry**

*Cultivated species.*—There are several species of plums and cherries in cultivation. Those oftenest found in Vermont are the following :

European or garden plum. *Prunus domestica* Linn. The common cultivated plum, including the Damsons, (the latter being var. *Damascena*). Tree strong, usually upright; leaves large, ovate or obovate, firm, thick, rough, coarsely saw-toothed.

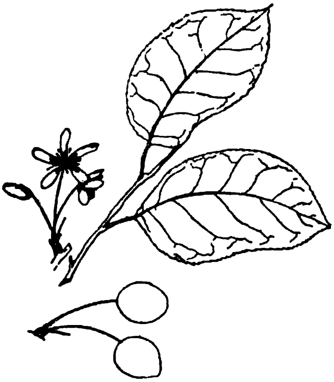
Japanese plum. *P. triflora* Roxb. A more slender willowy tree, with smoother, greener leaves, more finely cut-toothed.

Sour cherry. *P. Cerasus* Linn. The commonest cultivated cherry in Vermont. A comparatively small tree with smooth leaves ; fruit sour.

Sweet cherry. *P. Avium* Linn. A larger, straighter growing tree, seldom seen in Vermont ; leaves larger, dull and soft ; fruit usually sweet.

Other species sometimes cultivated are the following plums: *P. Simoni*, *P. cerasifera*, *P. Americana*, *P. augustifolia*, *P. hortulana*; the peach, *P. Persica*; and the apricot, *P. Armeniaca*.

CANADA PLUM (WILD OR HORSE PLUM). *Prunus Americana nigra* Waugh, *P. nigra* Ait., *P. Americana* Marsh. in part, according to Gray's Manual.



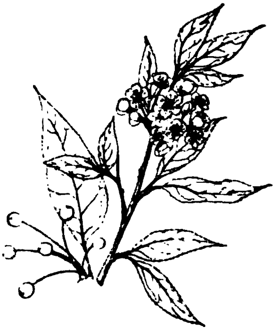
CANADA PLUM

Leaves, flowers and fruit, × ⅓.

The Canada plum, found frequently in Vermont, is a small tree or shrub, with grayish-brown bark and short, spiny branchlets. It may be recognized by its broad coarse leaves, sometimes four inches long and two or three inches wide. The flowers are abundant, large and strong, of a fine pinkish color, and appear about the first week in May. The fruit, often an inch in diameter, ripens in August. It is sometimes rather bitter, but occasional trees bear good eatable fruit.

WILD RED CHERRY (BIRD CHERRY). *Prunus Pennsylvanica* Linn.

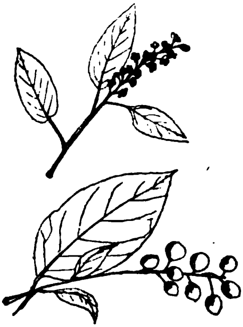
The wild red cherry, a small, slender tree, is quite generally distributed from the rocky woods of Newfoundland to North Carolina. It is common in all parts of Vermont where it is often only a roadside shrub. The flowers appear in May in beautiful white clusters on long pedicels. The fruit, which ripens in midsummer, is small and globular, becoming bright red when mature. This tree is distinguished from the other cherries by its slender and more graceful form, by its lighter colored, close-growing bark, often covered with transverse scars (lenticels), by its small flowers in spreading clusters and by its very small globular fruit similarly clustered.



WILD RED CHERRY

Leaves, flowers and fruit, × ⅓.

CHOKE CHERRY (WILD CHERRY). *Prunus Virginiana* Linn.

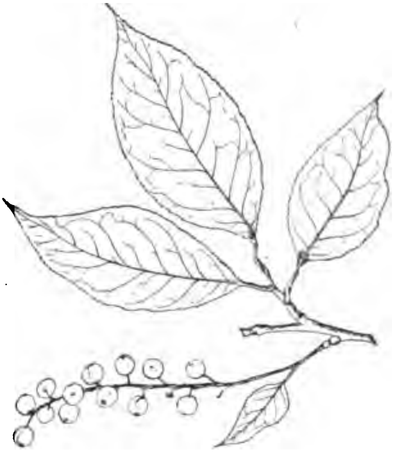


**CHOKE CHERRY**
Leaves, flowers and fruit, × ¼.

The choke cherry is usually a shrub in Vermont. It is, however, included in this list of trees because of its close relationship to the other cherries. It is very widely distributed in North America, ranging from the Arctic circle to California and Texas. In May, when the leaves are half grown, it is covered with creamy white flowers in long nodding clusters. The peculiarly astringent fruit, varying greatly in quality, however, ripens abundantly in August. It makes a good quality of jelly.

BLACK CHERRY. *Prunus serotina* Ehrh.

This is the only native Vermont cherry which reaches a sufficient size to make it a valuable timber tree. It has been exported in considerable quantities from the southern part of the state, but now large trees are seldom found. The wood is of very superior quality for cabinet making, and commands the highest price of any native American timber. It has a beautiful grain and takes a very fine polish. The flowers resemble other cherry blossoms and are borne in racemes. The fruit is at first dark red, then becomes almost black, with a thick skin and dark juicy flesh, which is generally rather bitter but sometimes sweet and pleasant.



**BLACK CHERRY**
Leaves and fruit, × ⅓.

## PULSE FAMILY

Most of the members of this family are easily recognized as such by their irregular flowers of the pea-blossom type, by their fruit pod, similar to that of the pea or bean, and by their compound leaves.

All of them which are native plants are herbaceous. Many of the species which grow further south are shrubs and trees. Several of the latter are commonly cultivated in Vermont, including four trees, the common locust, the clammy locust, the honey locust and the coffeetree.

The common locust (*Robinia Pseudacacia* Linn.) is a native of Pennsylvania and the more southern states. It has been widely planted in Vermont and has frequently run wild along fence-rows and about yards. The profusion of the fragrant white blossoms, the delicacy of the foliage and the picturesque form of the tree combine to make it very attractive. This locust is a large, rapidly growing tree. It makes the best of fence posts and it is said that it can be grown with profit for that purpose in this state.

The clammy locust (*Robinia viscosa* Vent.) is a smaller tree which is sometimes planted for shade or ornament and tends to spread. It is easily distinguished by the fact that its twigs and leaf-stalks are clammy or sticky to the touch.

The honey locust (*Gleditsia triacanthos* Linn.) is occasionally planted. It is conspicuous because of its long pods, (one foot or more) and its much branched thorns. The leaves are doubly compound.

The Kentucky coffeetree (*Gymnocladus Canadensis* Lam.) is also occasionally planted. The leaves are doubly compound and two or three feet long. The pods are five to ten inches long and one to two inches broad.

## MAPLE FAMILY

### MAPLES.

The maple family is a large one including nearly seventy species. Ten of these occur in the United States, and seven are found in Vermont. In many respects they form the most characteristic feature of our forest flora, and were we to select a state tree, popular choice would certainly be unanimous for the sugar maple.

The maples are easily distinguished from all other trees by their peculiar winged or "key" fruit. The leaves of all except the ash-leaved maple are also so similar as to form a good family character.

Two of the seven native species are as frequently shrubby as they are tree-like in both size and habit of growth, but all are included in this discussion. By appealing to the size of the tree and characters of the leaves it is possible to distinguish the species as follows:

- **Large trees.**
  - **Leaves compound (3-7 leaflets, resembling the ash.)....... .................. Boxelder**
  - **Leaves simple, with 3-5 prominent divisions or lobes**
    - **Leaves with terminal lobe more than ½ length of midrib ..............Silver Maple**
    - **Leaves with terminal lobes ½ or less than ½ length of midrib.**
      - **Bottom of sinuses (i. e. larger notches or indentations) acute, lobes sharply toothed............................................................ .....Red Maple**
      - **Bottom of sinuses rounded, lobes with few or no teeth.**

**Sinuses deep, lower surfaces of leaves smooth or with few hairs on veins.......................................................................Sugar Maple**
**Sinuses shallow, lower surfaces of leaves minutely hairy...........Black Maple**

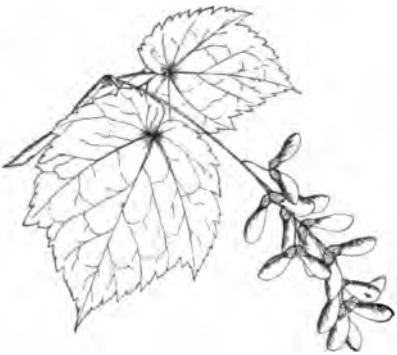
**Small trees or shrubs.**
**Leaves large (often 6-8 inches long), margins finely toothed, bark light green striped with darker lines. ..........................................Striped Maple**
**Leaves smaller (3-5 inches long) margins coarsely toothed, bark not striped....... .......................................................Mountain Maple**

*Introduced species.*—The Norway maple is a European species frequently used as a street shade tree farther south, and occasionally planted in Vermont. It most closely resembles the sugar maple among our native species but is easily distinguished by its broader and lower crown, larger leaves and larger, more divergent key-fruits.

Numerous horticultural varieties of the silver maple have been introduced in recent years, especially from Japan. These include very deeply cut-leaved forms, and also one with drooping branches. Their relationship to the native species is usually recognizable however.

The horse chestnuts and buckeyes are closely related to the maples, although some authorities place them in a separate family. Of these the European horse chestnut (*Aesculus Hippocastanum*) is very commonly cultivated. It forms a large, clean, symmetrical tree, with rich foliage and showy blossoms. The buckeyes of the south and west are occasionally planted.

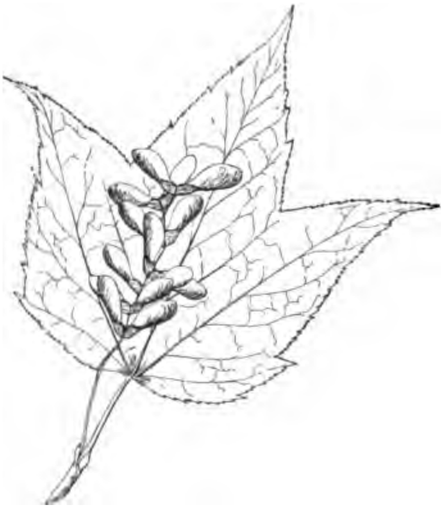
### MOUNTAIN MAPLE. *Acer spicatum* Lam.



MOUNTAIN MAPLE
Leaves and fruit, × ⅓.

The mountain maple rarely becomes more than a shrub in Vermont. It occurs commonly in moist, rocky mountain forests in all parts of the state. Like the striped maple it is partial to roadsides, and borders all our mountain driveways. The leaves are thin and downy on the under side. The greenish yellow flowers are borne in erect pubescent clusters which appear in the latter part of June. The fruits are very divergent, smaller than those of any other maple and become bright red in July and August. The heavy clusters then hang down and turn dark brown before being scattered by the winds. It is the spike-like arrangement of these flowers which suggested the Latin name of the species. This maple is one of the most highly ornamental of the smaller trees, and worthy of more general cultivation.

STRIPED MAPLE (MOOSEWOOD, STRIPED DOGWOOD). *Acer Pennsylvanicum* Linn.

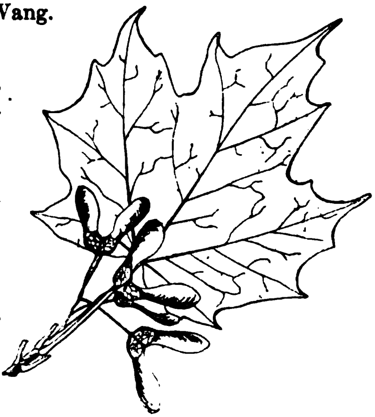


STRIPED MAPLE.
Leaf and fruit, × ⅓.

The striped maple is a small tree or shrub which forms a familiar part of the under growth of our forests, and is a common roadside bush in all parts of the state. It is easily distinguished by its greenish bark striped longitudinally with darker lines. The leaves, the largest of the maples, are usually from five to seven inches long and four or five inches wide. Its drooping clusters of greenish flowers unfold by the middle of June when the leaves are nearly grown. The fruits are abundant and turn a beautiful scarlet towards autumn. This maple rarely exceeds a height of twenty feet. It has also a distinct value for ornamental planting, especially in groups or borders.

SUGAR MAPLE (HARD MAPLE, ROCK MAPLE) *Acer barbatum* Michx., *A. saccharinum* Wang.

The sugar maple is at home everywhere in Vermont but it thrives best on the cool, rocky uplands of our state. It can be distinguished by its light gray bark which has large, white patches on the younger branches or by its broad, five-lobed leaves which have shallow, rounded sinuses. The small, inconspicuous flowers of the sugar maple appear with the leaves but the fruit does not ripen until late summer. This tree is widely distributed in North America but the fame of its sugar-bearing sap has mainly spread from Vermont.

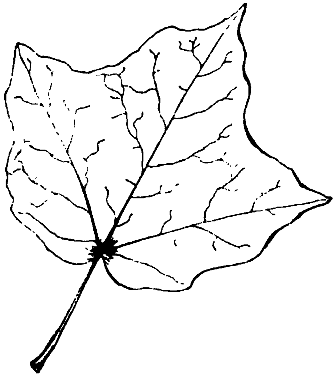


SUGAR MAPLE.
Leaf and fruit, × ⅓.

Besides its value as a sugar tree, its timber is hard and durable. It is extensively used for flooring, also for chair stock and other furniture and for fuel. The "curled" and "bird's-eye" maple are unusual forms of this species, produced by a peculiar curling of the fibers.

**BLACK MAPLE** *Acer barbatum nigrum* Sarg., *Acer saccharinum nigrum* T. & G., *Acer nigrum* Michx. f.

The above list of Latin names reveals the fact that this tree has long been a puzzle to botanists. In leaf characters it differs considerably from the sugar maple, but resembles it in fruit characters, general habit and in sugar production. As indicated in the key, the leaf is less deeply lobed, and is minutely hairy on the lower face ; it may also be hairy along the leaf stalk. It is thicker and more leathery in texture and is usually heart-shape at the base, the rounded basal lobes sometimes overlapping. The typical form of the leaf is shown in the accompanying figure.



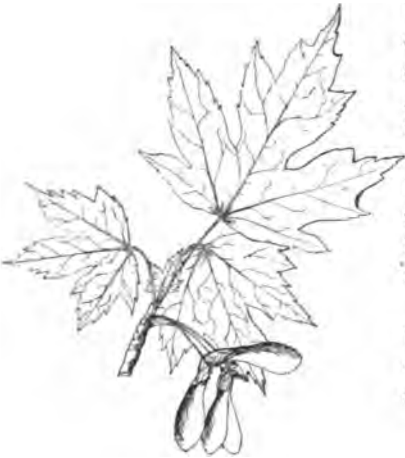
BLACK MAPLE, × ⅓.

It is common in portions of Canada and farther west. In Vermont it seems to be rare, and has not been reported outside of the Champlain valley, except at Windsor. Michaux found it at the latter place about a century ago and its rediscovery there would be of a considerable botanical interest. It is usually found in low, moist places.

This black maple should not be confused with specimens of the ordinary sugar maple having darker bark. Sugar makers often term such trees "black maples." The bark of this black maple is generally dark, but the leaf characters must be appealed to in its recognition.

**SILVER MAPLE (SOFT MAPLE, WHITE MAPLE, SWAMP MAPLE)** *Acer saccharinum* Linn., *Acer dasycarpum* Ehrh.

The silver maple is a large, graceful tree, generally distributed along our water courses, especially near the shores of Lake Champlain and the streams emptying into it. It resembles the red maple but is distinguished



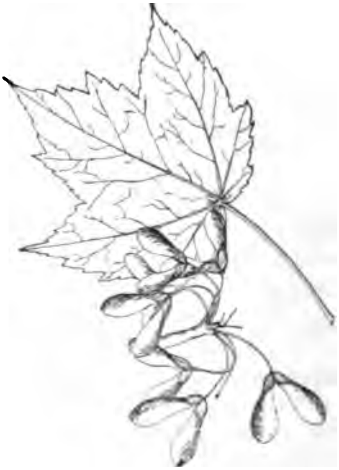
**SILVER MAPLE**
Leaves and fruit, × ⅓.

from it by its longer, more deeply cut, lighter green leaves which are silvery white on the lower side. Although the silver maple flourishes best in moist soil, it will make vigorous growth and become a beautiful shade tree in dry locations. It is not so hardy or long lived as either the red or the sugar maple in many situations.

The fruits are two or three inches long, larger than in either of the other species. They mature and fall in early summer.

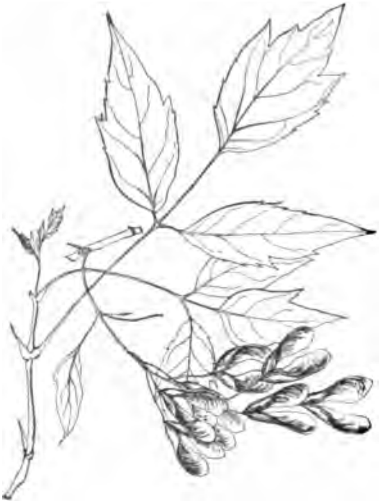
### RED MAPLE (SOFT MAPLE, SWAMP MAPLE). *Acer rubrum* Linn.

The scarlet flowers of this maple give us the brightest spring welcome from the trees. When the red maple is a blaze of color and the other trees are bare and brown, it is conspicuous and unmistakable, and in autumn the rich coloring of its leaves makes it conspicuous again. The leaves of the silver maple turn yellow and those of the sugar maple yellow or red, but not the crimson or deep red of the red maple. It is distinguished from the sugar maple by its smoother, dark gray bark and by the deeper acute incisions of the leaves although they are subject to much variation. The fruit is about one inch long and like that of silver maple falls in early summer. This tree, common throughout eastern United States, is very generally distributed in Vermont. It is especially found in low, moist soil. The red maple yields a sweet sap, inferior, however, to that of the sugar maple. The wood is rather soft with a fine smooth grain. "Curled" maple may occur in this species.



**RED MAPLE**
Leaf and fruit, × ⅓.

**BOXELDER (ASHLEAVED MAPLE).** *Acer Negundo* Linn., *Negundo aceroides* Moench.



BOXELDER
Leaves and fruit, × ⅓

The leaves of the boxelder are compound with three or five or sometimes seven slender, somewhat lobed leaflets.

In its general habit and appearance and especially in this leaf character the boxelder much resembles the ashes, hence one of its popular names. A glance at the peculiar key fruit, however, shows it is in reality one of the maples. Its flowers appear in May. The fruit becomes conspicuous by the latter part ot June but clings to the tree throughout the summer and autumn.

The boxelder occurs sparingly along streams in the Champlain valley, this marking its northern limit. It is very commonly planted, but its chief recommendation for this purpose is its quick growth.

## BUCKTHORN FAMILY

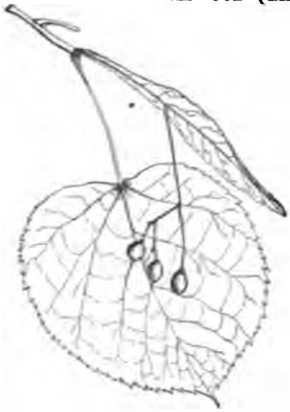
**BUCKTHORN.** *Rhamnus cathartica* Linn.

The buckthorn was introduced from Europe. It is commonly cultivated as a hedge plant, and occurs not infrequently as an escape. When left to itself it develops into a small and rather unsightly tree, bearing some resemblance to the wild plum. The most conspicuous character is its abundant fruit which occurs in clusters. It is berry-like with three or four seeds, one-third of an inch in diameter, and when ripe in autumn is black with green juice.

A medicinal syrup made from the berries was formerly much used. It is a powerful cathartic, and has fallen into disuse because of the violence of its action. Dyes can be made from different parts of the plant. The juice of the fresh berries yields a saffron color, and that of the bark a beautiful yellow. A fine green pigment used in water color painting under the name of sap-green is made from the berries in the early stages of ripeness.

## LINDEN FAMILY

BASSWOOD (LINDEN). *Tilia Americana* Linn.



BASSWOOD
Leaf and fruit, × ½

The basswood is a widely scattered tree in Vermont, growing with the maples, oaks and elms. Its leaves are five or six inches long and nearly as wide, with a base more deeply cordate on one side than the other.

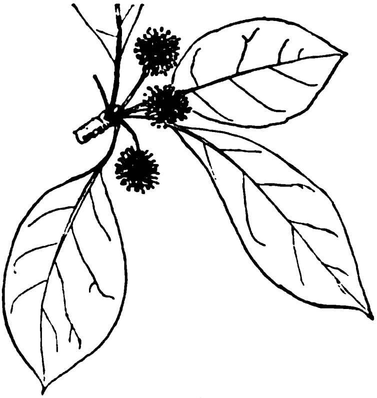
The flowers, which open in July, are creamy-white, borne in clusters suspended from a tongue-like leaf or bract. They are very fragrant and so full of nectar that the basswood is often called the bee-tree. The fruit ripens in autumn, forming hard, brown balls or nutlets the size of peas. These may quite thickly sprinkle the ground near the trees, and give rise to a plentiful crop of seedlings the following spring. The tough inner bark (bast) gave origin to the common name. Basswood lumber is brownish or nearly white, light but rather tough, and is extensively used for drawers and similar cabinet work, panels, inside wood-work and for toys. Owing to the fact that it is readily bent it is used also for the bodies and dash boards of carriages and sleighs.

The European linden (*T. Europea*) is occasionally cultivated. It closely resembles the American species.

## DOGWOOD FAMILY

SOUR GUM (TUPELO, PEPPERIDGE). *Nyssa sylvatica* Marsh.

The sour gum is found occasionally in swamps along the shores of Lake Champlain and in the adjacent river bottoms. It also occurs in the southwestern part of the state and has been found in the interior as far north as Craftsbury (Robbins). This tree has a peculiar appearance with horizontal branches and smooth or glossy leaves, borne in beech-like sprays. Its greenish yellow flowers appear in June and are followed by the dark-blue, egg-shaped fruits, one-half of an inch long, with thin, acid flesh, ripening in October.



SOUR GUM
Leaves and staminate flower clusters, × ½.

# OLIVE FAMILY

## THE ASHES

The olive family takes its name from the olive tree of Asia. The only representatives among our native trees are the ashes; but several of the commonly planted ornamental shrubs, the lilacs and other syringas, and the beautiful forsythia, belong to this family.

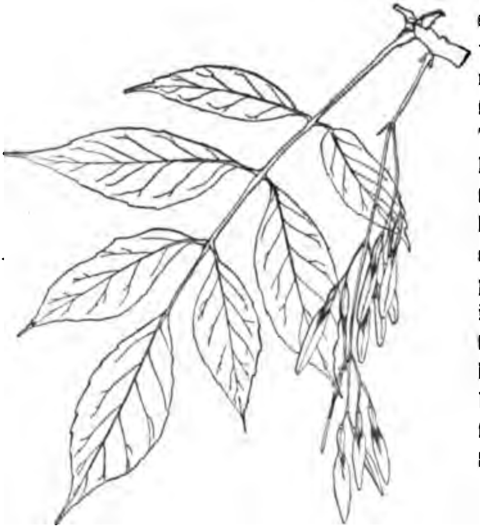
The individual flowers of the ashes are small. But the crowded clusters in which they appear before the leaves are quite conspicuous. The flowers are of two kinds, the pollen producing and the seed bearing being on separate trees. The ashes, like the maples, have prominently winged fruits, but those of the ash hang singly whereas the maple "keys" are always in pairs.

The ashes are among the most useful of the hard wood forest trees of America, yielding to the oaks alone in value. Two species, the black and the white, occur commonly throughout the state; the red and the green ash are restricted or local in their distribution. The latter two are very similar and intermediate forms connect them so closely that some authorities rate the green as but a variety of the red. In using the the following key it is to be observed that the ash leaf is compound, that is, each leaf is divided into from seven to eleven smaller leaflets, as will be seen by examining any of the figures.

**Lateral leaflets sessile (i. e., without distinct stalks)........................Black Ash**
**Lateral leaflets with distinct stalks.**
- **Buds, young shoots and leaf-stalks covered with fine velvety hairs....Red Ash**
- **Buds, young shoots and leaf-stalks, smooth.**
  - **Leaves paler or downy beneath.................................White Ash**
  - **Leaves smooth and bright green on both sides.................Green Ash**

## WHITE ASH. *Fraxinus Americana* Linn.

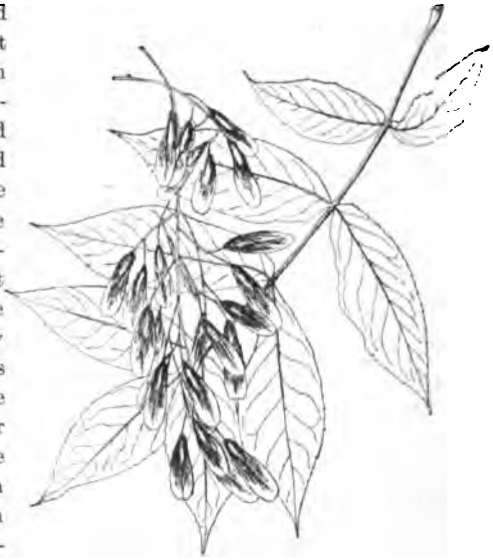
The white ash occurs in all parts of the state, and upon all kinds of soil, but it prefers a rich, moist location. It is an open spreading tree in the field but in the forest it sends up a clean, straight shaft with a very small head. This character helps to make the white ash one of the valuable timber trees of our forests. The wood is strong, tough, elastic, durable and easily worked. It is manufactured into casings, every kind of furniture, agricultural implements, and parts of carriages. It is said that in strength and elasticity the white ash timber from Vermont is superior to that from most other sources. The white oak and the hickories are the only native trees which have a higher value for fuel. This ash is recognized by its compound leaves, about twelve inches long, with from five to nine smooth, petioled leaflets. The flowers appear before the leaves and the fruits ripen in August or September.



WHITE ASH
Leaf and fruit, × ⅓.

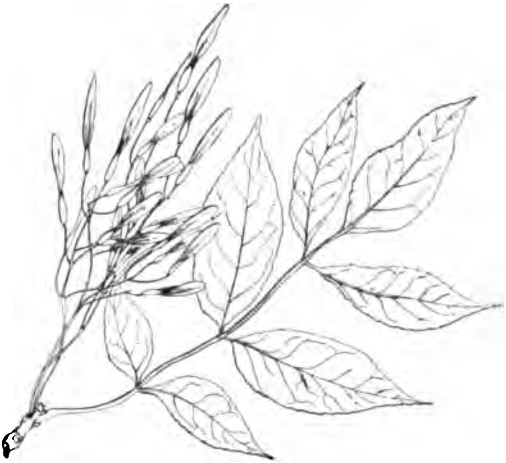
BLACK ASH. *Fraxinus nigra* Marsh., *F. sambucifolia* Lamarck.

The black is ash is found in lowlands or swamps. It is often called the brown ash but this name is confusing as it is also applied to the red ash. This and the white species are the commoner ash trees of the state. They are easily distinguished by the fact that the leaflets of the white ash are always distinctly stalked while the black has sessile leaflets. These are seven to eleven in number often forming a leaf twelve to sixteen inches long which is smooth and green on both sides. Black ash timber is coarser grained than is that of white ask. It is used for furniture and inside finishings and in the manufacture of baskets.



BLACK ASH.
Leaf and fruit, × ⅓.

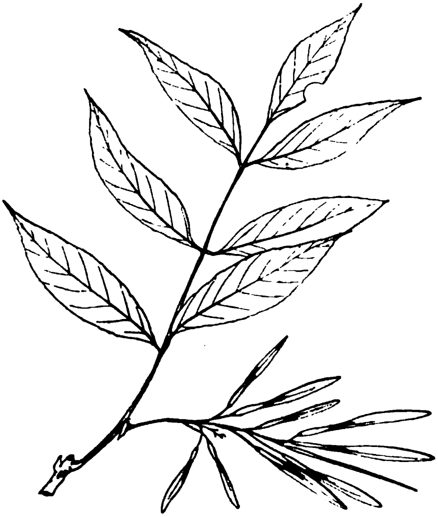
**RED ASH.** *Fraxinus Pennsylvanica* Marsh., *F. pubescens* Lamarck.



RED ASH
Leaf and fruit, × ⅓.

The red ash closely resembles the white ash in general appearance. It may always be recognized however, by looking closely at the buds in winter or at the young shoots or petioles in summer. These parts are velvety with delicate hairs, and it is this characteristic pubescence which suggested the Latin name of the species. The flowers and fruits bear a general resemblance to those of the white ash. The red ash is used considerably in manufactures but is inferior to the preceding species for most purposes. It is generally distributed along the shores of Lake Champlain and its adjacent waters but has not been reported from other parts of the state.

**GREEN ASH.** *Fraxinus lanceolata* Borkh., *F. viridis* Michx.



GREEN ASH
Leaf and fruit, × ⅓.

Sargent considers this a variety of the red ash which it strongly resembles. The best means of distinguishing the green ash from the red is by its smooth buds, branchlets and leaf-stalks. It takes its name, green ash, from the fact that the leaflets are bright green on both sides, whereas those of both the white and the red are paler beneath. But these characters show clearly only in decided forms and perplexing intermediate forms may be found. It is known to occur sparingly on the shores of Lake Champlain, and probably does not grow native elsewhere in the state.

# BIGNONIA FAMILY

## THE CATALPAS

Catalpa or indian-bean trees are occasionally planted in Vermont, although they are not always hardy. The peculiarities of fruit and foliage give them a somewhat tropical appearance. The leaves are heart-shape and very large, six to twelve inches long; the flowers are one or two inches across and the cylindrical pods nearly a foot in length. The species most commonly planted is the hardy American catalpa (*C. speciosa*). The Japanese catalpa (*C. Kæmpferi*) is less commonly planted, but Mr. F. H. Horsford of Charlotte, who has it in cultivation, finds it to be hardy.

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# AND STATE AGRICULTURAL COLLEGE

# VERMONT AGRICULTURAL
# EXPERIMENT STATION

BURLINGTON, VT.

# BULLETIN No. 74

DECEMBER, 1899

## The Home Fruit Garden

I. The Beginning
II. The Planting
III. The Tending

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1900.

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Director's office, chemical and horticultural laboratories are at the Experiment station building, at the head of Main street; botanical and entomological laboratories are at Williams Science Hall, University place.

Experiment farm and buildings are on the Williston road, adjoining the University grounds on the east.

# BULLETIN 74: THE HOME FRUIT GARDEN

By F. A. Waugh

> **"If I were asked to say what single aspect of our economic condition most strikingly and favorably distinguished the people of our northern states from those of most if not all other countries which I have traversed, I would point at once to the fruit trees which so generally diversify every . . . farm. . . The average New England . . . homestead, with its ample apple orchard and its cluster of pear, cherry and plum trees surrounding its house, . . . has an air of comfort and modest thrift which I have nowhere else seen fairly equaled."**—*Horace Greeley.*

Grand Isle county is beginning to have a considerable reputation for fine fruit. Other counties in the state where fruit can be grown successfully are Franklin, Orleans, (witness Dr. Hoskins), Essex, Lamoille, Chittenden, Washington, Caledonia, Addison, Orange, Rutland, Windsor, Bennington, and Windham.

Probably every state in the union has seen the time when a majority of men have said that the country was not adapted to fruit growing. In most states this opinion still prevails alongside many adequate proofs of its incorrectness. There are many farmers in Vermont who still spend their days in the error of thinking that fruit can not be successfully grown on their farms.

It is safe to say that any farm in the state which will grow anything will grow an abundance of fruit for the family use if reasonable attention is given to it. It is certainly a shame for a family to live on a farm year after year without what fruit is needed for the table. What do such families live on the farm for, anyway? It can't be for their health, for such families seldom present a robust appearance. Why is it?

The large majority of farmers unaccountably do not grow fruit enough to supply their own families, though most farmers make some effort to grow more or less fruit for home use. There are very few who intend to go without entirely. A few suggestions regarding the management of the home fruit garden may prove acceptable to those who want to do better.

## I. THE BEGINNING

*Choice of location.*—The home fruit garden should be near the house, for the convenience of the family, and not too near the road, for the convenience of the public. It should be of reasonable size. On most farms it ought to comprise at least one acre. It should be located on the best land available. The soil should be not only rich, but deep, well drained and easily worked. Deep soil and good drainage are more important than fertility. A loose, gravelly subsoil covered with a heavy sandy loam which does not bake makes an ideal situation for a fruit garden. A slope to the east is probably best, though this matter is not of first importance. Slightly sloping land is better than perfectly level land. The fruit garden should not come at the bottom of a slope, and especially not in a pocket of low land.

The fruit plantation ought to be protected by windbreaks on the north and the south. However, if the land slopes, care should be taken not to have the windbreak too dense on the lower side, as it keeps the cold air from running off. The most convenient material for a windbreak is usually the native arbor vitæ—usually miscalled white cedar. Spruces or pines make good windbreaks in some cases. A belt of deciduous trees or natural forest often serves this purpose admirably, but is more apt to be the harboring place of insects, especially tent caterpillars.

*Preparation of the soil.*—Before fruit trees are set out the soil should have thorough preparation. It should be remembered that the crop is to stay on the ground for years to come, and also that the roots of fruit trees reach deep into the soil. The ground should be plowed just as deeply as possible. If the subsoil will admit of it, subsoiling will be worth while. Persons who are anxious to grow the very best of fruit will sometimes find it practicable to trench small parts of the garden. The soil and the subsoil should be in the very best of mechanical condition before the trees are set. A shortage of plant food may be made good later, but insufficient opening of the soil cannot be easily remedied.

Drainage is of much importance. The deep loosening of the soil is valuable largely in assisting the land to rid itself of superfluous water; and a piece of land which drains well is one which also holds moisture well during drought. Land which requires surface ditches for drainage will not do for fruit, but sometimes land which is naturally very wet can be drained with tile in such a way as to be second to none other for fruit.

## II. THE PLANTING

*How to get trees and plants.*—The tree agent is an unnecessary evil. He has done much good in the land by selling trees and plants to hundreds of persons who would never have bought without his importunities; but any man who can read can do much better without the tree agent. That is, he can do better providing he will buy the same number of trees without persuasion. Most men let matters drift when left to themselves, and would never order a tree in the world if they were not urged and exhorted to.

Every good agricultural paper carries the advertisements of several reputable nurseries. The experiment station sometimes directs inquirers to convenient and reliable nurserymen. From these firms trees can be bought direct at prices usually less than half what the agent is forced to charge. Better trees are also secured. First class apple trees can be bought of nurseries at 15 to 25 cents apiece. In quantities they can be bought for less. Pear trees cost a little more ; plum trees about the same ; grape vines a little less.

All sorts of fruit trees and bushes may be set either in fall or spring ; but spring setting is generally to be advised for this state, especially for beginners. The trees should be ordered delivered at planting time, which comes here during April.

When the stock is received it should be set as soon as possible. In case it cannot be set at once the root ends of the trees should be buried in a trench under soil sufficiently deep to keep them from drying out. Small batches of plants, if well wrapped, can often be held for a few days in an ice house to good advantage.

When the trees are ready to set the tops should be trimmed slightly, all broken limbs being taken off and the head balanced up to a comely and symmetrical shape. All broken roots should likewise be removed. Holes should be prepared considerably larger than what is necessary to receive the roots. Apple trees usually should have holes made for them two feet across and sixteen inches deep,—other trees and plants in proportion.

When large plantations are set care should be taken to mix varieties more or less ; and in small gardens one or two plants of a single variety should not be set alone. This is especially true of pears and plums, of which there should always be two or three varieties blooming at the same time to insure cross-pollination.[1]

It is usually best to adopt some unit of distance for a small home garden, and make all the tree and plant rows match. This facilitates cultivation. A convenient unit is the rod. Plum, pear, and cherry trees may be set a rod apart ; apple trees two rods ; grape vines a half rod ; currant and gooseberry bushes a third or a fourth of a rod apart. If this plan is not thought feasible, the following table of distances for planting may be of use:

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[1] This subject is discussed more fully in Bulletin 53 and in the 10th, 11th, and 12th reports of this station.

### DISTANCES APART FOR PLANTING

| | | |
|---|---|---|
| Apples | 35–40 | feet |
| Pears | 20–25 | “ |
| Plums | 15–20 | “ |
| Sour cherries | 15–20 | “ |
| Blackberries | 4 x 6 to 6 x 8 | “ |
| Raspberries | 3 x 5 to 3 x 8 | “ |
| Currants | 4 x 5 to 4 x 6 | “ |
| Gooseberries | 4 x 5 to 4 x 6 | “ |
| Grapes | 6 x 10 to 8 x 12 | “ |
| Strawberries | 1 x 3 to 1 x 4 | “ |

*Varieties for planting.*—A man should always plant the varieties he likes best. This is especially true in starting a home fruit garden. In the home orchard there should be found all the family favorites. Some folks like Pound Sweets; others have a special fancy for Northern Spy; or some member of the family thinks that Blue Pearmain is the finest apple that ever grew. Similar preferences are to be found with other fruits; and all these should be carefully regarded in making the selection for the home garden.

Beyond this point it is more or less risky for one man to recommend varieties to another. In the following lists, which are necessarily very brief, some of the best varieties are mentioned which are known to succeed in this state. Usually more varieties are named than any one family will care to plant. This is done so as to leave some room for selection. Varieties are generally named in the order of the author's preference.

*Apples.*—In the Champlain and Connecticut valleys, and the southern part of the state, the following varieties succeed:

*Summer*

Early Harvest
Primate

*Autumn*

Porter
Oldenburg
Lowell
Gravenstein
Fameuse
McIntosh

*Winter*

King
Spitzenburgh
Spy
Rhode Island Greening
Baldwin
Arctic
Golden Russet
Hubbardston
Seek-no-further
Belleflower
Tolman (sweet)

For the colder parts of the state the following varieties are recommended :[1]

*Summer*

Yellow Transparent
Red Astrachan

| *Autumn* | *Winter* |
|---|---|
| Oldenburg | Scott Winter |
| Longfield | Pewaukee |
| Wealthy | Arctic |
| Fameuse | Wagener |
| McIntosh | |

*Pears.*—In most parts of the state, excepting only the colder and more exposed situations, pears may be grown successfully. Even in the coldest spots some of the Russian varieties will grow and fruit, but none of them can be freely recommended for the home garden. The following varieties are best adapted to Vermont : Vermont Beauty, Flemish Beauty, Beurre d'Anjou, Winter Nelis, Onondaga, Tyson, Lawrence, and Sheldon. Others which succeed in many gardens are Duchesse d'Angouleme, Bartlett, Buffum, Seckel, and Louise Bonne de Jersey.

*Plums.*—This delicious fruit, which is excellent fresh, canned, or preserved, should be more generally and abundantly grown in home gardens. There are literally hundreds of good varieties which can be grown in most parts of the state. The following lists are hardly more than suggestive.[2] For the warmer localities the following sorts are good : Burbank, Lombard, Abundance, Bavay—taking the place of Green Gage—Chabot, Pond, Golden Drop, Grand Duke, Wildgoose and Wayland. For the colder parts of the state the following sorts may be chosen : Stoddard, Hawkeye, Quaker, Aitkin, Surprise, Cheney, Desoto, Forest Garden, Wolf, Wyant, Weaver. All these are as hardy as sugar maple trees, and can be planted anywhere.

*Cherries.*—Only the sour cherries succeed in Vermont. The following varieties have proved entirely satisfactory, and two or three of them should be found on every farm : Morello, Montmorency, Brusseler Braun, Bessarabian, Early Richmond.[3]

*Grapes.*—This delicious fruit is unfortunately almost unknown on Vermont farms. Yet it can be grown with fair success anywhere in the state by choosing proper varieties and giving a little attention to methods of growing.[1] About the only variety which will ripen well in Newport and similarly cold localities is Green Mountain (or Winchell). At Burlington the Concord will ripen well about one year out of three, and will get its color about four years out of five. Varieties earlier than Concord can be planted with some confidence in all parts of the state having a season similar to that at Burlington. The experiment station has given special recommendation to the following: *Black*,—Moore Early, Worden; *Red*,—Moyer, Brighton, Wyoming; *White*,—Green Mountain.

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[1] Consult bulletin 61 on this subiect.

[2] Various publications of the Vermont experiment station deal with plums.

[3] For further notes on cherries see Vermont experiment station report 12, pages 240–251.

As a second choice the following varieties may be mentioned: *Black*,—Concord, Merrimac; *Red*,-Brilliant, Delaware, Salem, Vergennes; *White*,-Diamond (Moore's), Niagara.

*Blackberries*.—Several varieties of blackberries have been tested at the station, of which Ancient Briton has uniformly succeeded best. Other varieties have proved better in other parts of the state, however, and with other growers. The following may be named as good, reliable sorts: Agawam, Snyder, Taylor, and Early Harvest.

*Raspberries*.—The most successful red raspberry in this section is, without exception, the Cuthbert. Other varieties which have done well are Marlboro, Shaffer and Columbian.

The black raspberries are not so generally grown, but are equally indispensable for the home garden. Probably the best varieties are the following: Palmer, Kansas, Gregg, Souhegan, Tyler and Older.

*Currants*.—Cherry, Victoria, and Versailles are the best red currants; and red currants are what most folks want. White currants are desirable for dessert use. White Imperial or White Grape may be chosen.

*Gooseberries*.—Downing is the standard American gooseberry, though some of the newer varieties, like Red Jacket, Champion, and Pearl are worth trying.

*Strawberries*.—There is a long list of strawberries to choose from, and the selection of varieties for home use is more a matter of personal taste and less a question of which will succeed best than with most other fruits. Among those which are favorites in this state may be mentioned the following: Glen Mary, Warfield, Clyde, Crescent, Bubach.[2]

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[1] Consult bulletin 62, "Home Grown Grapes in Vermont."

[2] Mr. A. A. Halladay, an experienced strawberry grower of Bellows Falls, recommends Glen Mary, Wm. Belt, Clyde, Tennessee Prolific, Bissel, Greenville, Brandywine Warfield, in this order.

## III. THE TENDING

*Cultivation.*—There is a sadly incorrect notion abroad to the effect that an orchard does not need cultivation. Fruit trees should be as well tended as any other crop on the farm; and if they are better tended they will amply repay their owner. It is true that pear trees may be over-cultivated, and that cherry trees do not require the same stimulation which many other farm crops do; but in general it may be said that the very best of cultivation, and nothing less, is what pays in the fruit garden.

It is now pretty well settled that the best management for orchard ground is to plow it early in the spring, as soon as it is dry enough to work well, to give it frequent surface cultivation from that time till the middle of July, and then either to "lay it by" or sow it with a cover crop.

With regard to the first plowing it may be remarked that the plow should be sent down to a good depth. If this treatment is begun when the trees are first planted there will be no large roots formed near the surface where they can interfere with the plow. If the orchard is old and the roots are near the surface it will do no hurt to cut a few each year till the upper soil is open and free for the passage of the plowshare. The trees should also be pruned in such a manner as to allow the plow to come up close to them. This can be done and still have lower heads than many Vermont farmers give their apple trees. (In the opinion of the writer, the first branches of an apple tree should leave the trunk at from three to five feet from the ground; not more).

The successive cultivations in the orchard and fruit garden during the summer should follow one another at intervals of ten days to two weeks, or oftener if the weather is dry. A sharp harrow, or a spring-tooth harrow, or a light corn cultivator may be used. The object of this work is to keep the surface thoroughly pulverized, and thus to prevent the soil from drying out.

The cover crop mentioned above should be sown as soon after the tenth of July as can be done, observing that the surface soil is freshly tilled and that the seed is put on just before or after a good rain if possible. A favorite cover crop in this country is peas and buckwheat. These should be mixed and sowed at the rate of about two bushels each to the acre. Mammoth clover is probably a better cover crop than peas and buckwheat. It should be sowed heavily in the same way. Vetch, oats, winter rye, and other plants have been recommended and more or less used. The leguminous—nitrogen-gathering—plants are best; but anything which will make a mat of herbage, keep down the weeds, hold the snow during winter, and furnish a quantity of vegetable matter to plow under in the spring, serves the purpose of a cover crop.

*Fertilization.*—The garden should be made rich in plant food. The best way to do this is to be liberal with dressings of barnyard manure. Caution needs to be exercised with pear trees, which are easily over-fed. Cherry trees need only a small amount of fertilizer, and Japanese plums should not be unduly forced by too much feeding. Most trees and fruit bushes, however, give best results when liberally supplied with manure.

*Pruning.*—Each kind of tree needs its special kind of pruning; and there are so many things to be considered that an entire book would be required to give satisfactory directions. The best that can be said is that common sense needs to be used in this sort of work, and that no amount of instruction will take the place of it. Apple and pear trees should be pruned to keep the heads open. Plum trees should be pruned to keep out the black-knot; and some of the Japanese varieties need frequent cutting back. Cherry trees should not be pruned unless branches are broken or interfering. Pruning grape vines is an art by itself. Brief directions are given in our bulletin 62. Blackberries, raspberries, and other bush fruits should be pruned by the removal of old dead stalks early each spring. All pruning can best be done very early in spring, after the worst of the winter is over but before the sap starts.

*Winter protection.*—We find it a good plan to bank up fruit trees to the height of eight to twelve inches in the fall. This prevents water settling about the roots, and saves much damage from mice. Grape vines are best taken off the trellises and laid on the ground with a few evergreen branches thrown over them. This will catch the snow and keep the buds from killing by freezing during the winter. Strawberries are usually best cared for when lightly mulched in the fall, though this does not serve on all soils. Every man must be guided chiefly by his own experience in this matter. Other fruit plants will usually take care of themselves through the winter; but care should be taken that heavy drifts of snow do not form on the berry patches or the canes are apt to be badly broken down when the snow melts.

*Diseases and insects.*—A fruit garden which is well cared for will usually not suffer materially from insects and diseases. There are, however, several of each always ready to make an invasion the moment the farmer's industry is in the least relaxed. Often insects and fungi get a start in spite of all that can be done. Well directed spraying, which is not a difficult or expensive undertaking, will prevent the ravages of most insects as well as of most fungi. The treatment of these various pests has been very thoroughly studied by the experiment station; and we are able to give useful advice in nearly all cases where we are consulted. The station has published many reports and bulletins on these subjects, and they may be consulted on occasion.

*Asking questions.*—There are usually a few well-informed fruit growers in every neighborhood,—those who have a taste for gardening rather than for grain or dairy farming. The general farmer who keeps a fruit garden only for the benefit of his family, will do well to consult his horticultural neighbors as often as possible. All the agricultural papers give considerable attention to horticultural matters, and are always ready to answer questions which are sent to them. Many of these papers employ the best experts in the country to answer these questions, and the farmer who is in doubt about any practical matter will do well to consult them. The experiment station feels itself in duty bound to answer every reasonable horticultural question sent it, as far as falls within the knowledge of its officers; and those who do not find in this little pamphlet the information they require should address their inquiries to

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